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The Copeland Steam Engine.

The engine which we illustrate on this page, and on page 2, has been brought out as the result of a good deal of study by the inventor, Mr. Lucius D. Copeland, whose aim has been to produce a light, compact and strong motor of small power, and one that could be operated by those not specially skilled as engineers.

On page 2, this engine, which uses gasoline for fuel, is shown attached to a bicycle, the engine and boiler, with fittings, we are informed, weighing but 18 lbs.

The large upright part is the boiler, the globe-shaped piece the water tank, and the diagonal parts the oil tank and engine.

The latter is of the reciprocating type, cylinder $1\frac{1}{16}$ by 3 inches, and furnished with Meyers' cut-off valves, which can be made to cut off the steam at any part of the stroke of the piston by turning a small hand-wheel. On the outer end of the engine shaft is a grooved wheel, four inches in diameter, from which runs a round belt, three-eighths of an inch in diameter, to a grooved rim, thirty-six inches in diameter, soldered to the spokes on one side of the large wheel of the bicycle. Underneath the four-inch wheel, it will be observed, is another small wheel, which is used to tighten the belt.

The burner for the oil is located in the lower part of the boiler; a small rod running down to the burner serves as a medium for the regulation of the amount of heat required; it permits of its operation from the saddle, while the machine is running.

The throttle valve is attached to the brake lever; when the lever is allowed to go down the throttle is opened, and when it is brought up it is closed, and the brake applied to the large wheel.

The machine is provided with a headlight, whistle, safety-valve, etc., and has frequently, we are told, been run with a steam pressure of one hundred pounds, and at a rate of ten miles per hour, on smooth and level ground. A supply of fuel to last for several hours can, of course, be carried, if the capacity of the tanks be increased. In ascending a hill the usual treadles can be used to assist the engine.

The engine shown in this cut will develop one-half horse-power, while the boiler for the same will develop a little less than one-quarter horse-power.

The inventor has also brought out a twin cylinder engine for a tricycle, which is shown in the cut on page 2.

It will be observed that the boiler is located directly back of the rear seat. The engines are located horizontally on the reach or backbone of the machine, and are connected to the balance gear on the main axle of the driving wheels by noiseless gearing, and are immediately back of and below the water tank in full view of the operator. In appearance they resemble a pair of extended opera-glasses, and weigh but six pounds

The tank, which is divided into compartments for water and oil, is situated under the forward seat. The driver occupies the rear seat and controls the machine by means of the brake-lever, which is attached to the throttle in a manner similar to that of the steam bicycle.

The machine will start without jumping or jarring, and will attain its maximum speed as the lever is raised to its highest point. To stop the machine, throwing down the lever to its lowest point cuts off the steam and applies brake. The water and fuel supplies are entirely automatic. Enough fuel will be carried for a run of twenty-five miles. The entire weight of the machine with tanks filled is 185 pounds. There is no more danger of frightening horses than with the ordinary tricycle, as there is no noise of escaping steam.

The Northrop Manufacturing Company, of Camden, N. J., with which Mr. Copeland is connected, will place upon the market on March 1st a two horse-power Copeland engine in its stationary form, shown on page 1. This is an automatic petroleum vapor burning safety engine designed for use in pumping water, running ice-cream freezers, lathes, blowers, polishing wheels, dynamo electric machines, air pumps, printing presses, churns, choppers, or for any purpose where small power is required.

As noted, petroleum is used, being supplied from a tank (by pressure obtained by gravity or by an air pump whichever is preferred) to an improved form of retort burner in which it is converted into vapor, forced into the fire chamber and ignited.

The fire can be started at once, independently of pressure in the boiler, but when started is regulated automatically by that pressure.

THE COPELAND STEAM ENGINE.

The water level is maintained by a float regulator governing the supply cock of the pump and sounding an alarm should the supply in the tank become exhausted. Should this preventive fail, an extra precaution is taken by the insertion of a plug which will be released after the water passes a given level, when the pressure in the boiler will expel the water remaining, putting out the fire, and causing no damage and little delay.

The speed of the engine is controlled by a new spring governor contained within the fly-wheel, whereby rigid and direct connection with the throttle without lost motion is obtained.

The engine is constructed to run at a high speed, all moving parts and bearings being made of steel, hardened and ground by special machinery to perfect cylindrical surfaces, and, as they are constantly moving in oil, the wear is almost imperceptible. No disastrous explosions are possible with this motor.

The boiler consists of several upright tubular compartments *A* (page 2), arranged around a central tubular compartment *B*, and having on their inner sides or interiors fire flues *a a*. Depending from the bottom of each of these outer compartments are three drop water tubes *a' a'*, which extend into the fire chamber. Leading from each of the outer cylinders at their tops into the dome or central cylinder *B*, are curved connections or pipes *C C*, which are fastened at one end in the wall of the dome, and are united by joints or union couplings *c c* at their other ends to the outer compartments, so as to permit of their ready removal in case of accident from any cause. In the center of compartment *B*, and surrounded by the fire flues *b b*, is a tube *D*, firmly secured in the bottom of said compartment, and extending upwardly to within a short distance of the top. On the inside of tube *D* is another and smaller tube *d*, which is secured at its upper end in the base of safety valve *E*, and extends downwardly into a drum *F*, which drum serves as a super-heater for the steam, which is admitted at the top of tube *D* and passes down into the drum; the steam then passes up through the tube *d*, and thence through steam pipe *e* to the engine. Drum *F* is secured to the lower end of tube *D*, and depends therefrom into the fire chamber. The above construction of boiler gives large heating surface, perfect circulation, and, consequently, even and rapid generation of steam.

Petroleum oil of from 110° to 150° fire test can be purchased, it is said, at from five to ten cents per gallon, and four gallons will be sufficient to run a two-horse Copeland engine, doing full duty, for ten hours. The weight of the two horse-power engine and boiler complete is but one hundred pounds.

No smokestack is required or heavy foundation needed. The engine is said to make no more noise than an ordinary sewing machine when running.

Copper Steam Pipes in Marine Service.

BY W. H. HOFFMAN.

The late accident on the English steamship Elbe, will, I think, produce a beneficial effect in marine engine construction, although the lesson was a terribly fatal one. It is much to be regretted, that, in the so-called investigations following such distressing accidents, there is generally more or less cloud and mystery surrounding them. For the benefit of science as well as humanity, these investigations, or trials, should be honestly conducted, at no time allowing the question of civil or criminal damages to enter into their deliberations. First, find who and what is at fault, and then fix the responsibility without fear or favor, and if such a course cannot be conscientiously followed, there is no use of an investigation.

A short time ago there was an appalling railroad accident near Boston, caused by the falling of a flimsy bridge, and while the investigation was in progress, the men of science were fighting desperately against the men of money, in order to reach the truth. This is all wrong, and the men of money in this case have admitted as much, and are now taking methods to improve and strengthen all the bridges and similar structures on their property.

When a steamship puts to sea to face the elements, she also carries with her elements of sure and swift destruction, which are necessary for her propulsion. Who can doubt the result of the explosion of an 800 horse-power boiler on shipboard? and yet many of the large ships have eight or ten such boilers.

Then there is the system of live steam piping with all the valves and joints that are liable to sudden failure. When the old low pressure condensing engines were the marine motors, the large copper pipes rarely failed, and when an accident did occur, it could generally be traced to inferior metal or workmanship. The pressure then ranged from 20 to 50 pounds per square inch; the pressures now are never below 90 pounds, and more frequently run as high as 160 pounds per square inch. It is well known that heavy or thick sheet copper is not as sound as the thin sheets; in fact, with the modern appliances for casting copper ingots, they are often found to be very unsound. Thus it will be seen that we are using a metal for our steam pipes in marine service with a variable ultimate strength of from 22,000 to 35,000 pounds, while we take the trouble to make steel boilers that have a uniform ultimate strength of 60,000 pounds per square inch of section.

Experiments made since the explosion on the steamship Elbe, show that from 26,000 to 29,000 pounds per inch of section, is all the average copper sheet will stand when put to the breaking point, while overheating in making the pipe reduces this to 24,000 pounds.

The exploded pipe of the Elbe was $9\frac{1}{2}$″ diameter inside, 6′ 9″ long, and $\frac{1}{4}$″ thick. The opening made in the pipe by the explosion was oval, 3 feet long and 9 inches wide at the center. Nine men, engineers and firemen, were instantly scalded to death, and one fireman died the next day from injuries received in the stokehole. At the time of the accident the steam pressure was 150 pounds per square inch, that being the regular working figure.

It appears from the evidence, that every care was taken, in making this pipe, to have it equal in working strength to the pressure carried, and the writer thinks there are many copper pipes afloat, that would fail completely under the tests that this pipe was subjected to. We may therefore say that we cannot expect to get more than 5,000 pounds safe working strength of one sectional square inch of a copper steam pipe.

I have seen copper pipes reinforced by having rings brazed on them, and others by having copper wire coiled closely around them, the whole being brazed together; but the process in both cases is expensive, and the results not always satisfactory; conse-

quently there appears to be no practical way of strengthening a sheet copper pipe. Knowing the particulars in several failures of copper pipes, since high pressure steam has been introduced, the writer has concluded that there is one practical method, at least, of preventing steam pipe explosions.

My plan would be to at once reduce the diameter of these pipes, and compensate for the reduction by casting a live steam receiver, or jacket reservoir, around the initial or high pressure cylinder.

In this reservoir should be placed a live steam coil, to prevent condensation, while the reservoir itself would be in direct communication with the high pressure cylinder steam chest.

The capacity of the reservoir should be three times the capacity of the high pressure cylinder, supposing the average point of cut-off to be at half stroke. Having such a large supply of steam, so near the main valves of the engine, we are enabled to reduce the steam pipe area quite materially.

Of course we shall increase the velocity of steam flow in the pipe at the time of cutting off, but we have, previous to this, raised our initial cylinder pressure to the economical point by having an abundant supply of steam near at hand, when the main valve is first opened.

In the case of the Elbe, an 8″ pipe, feeding a reservoir of the capacity named, would give the same results, as to initial pressure, as a 9½″ pipe leading to a small steam chest; then again, the flow from the boiler through the 8″ pipe to the reservoir is continuous, while the flow of steam from the reservoir to the piston is intermittent.

Now I should not put in an 8″ pipe in place of the 9½″ pipe, but should provide 52 square inches in two copper pipes, leading to two throttle valves, these being worked in combination, or separately. Each of the pipes would be 5¾″ diameter inside, and ¼″ thick, thus increasing the ultimate strength of the steam connection between the boilers and the high pressure cylinder over 60 per cent.

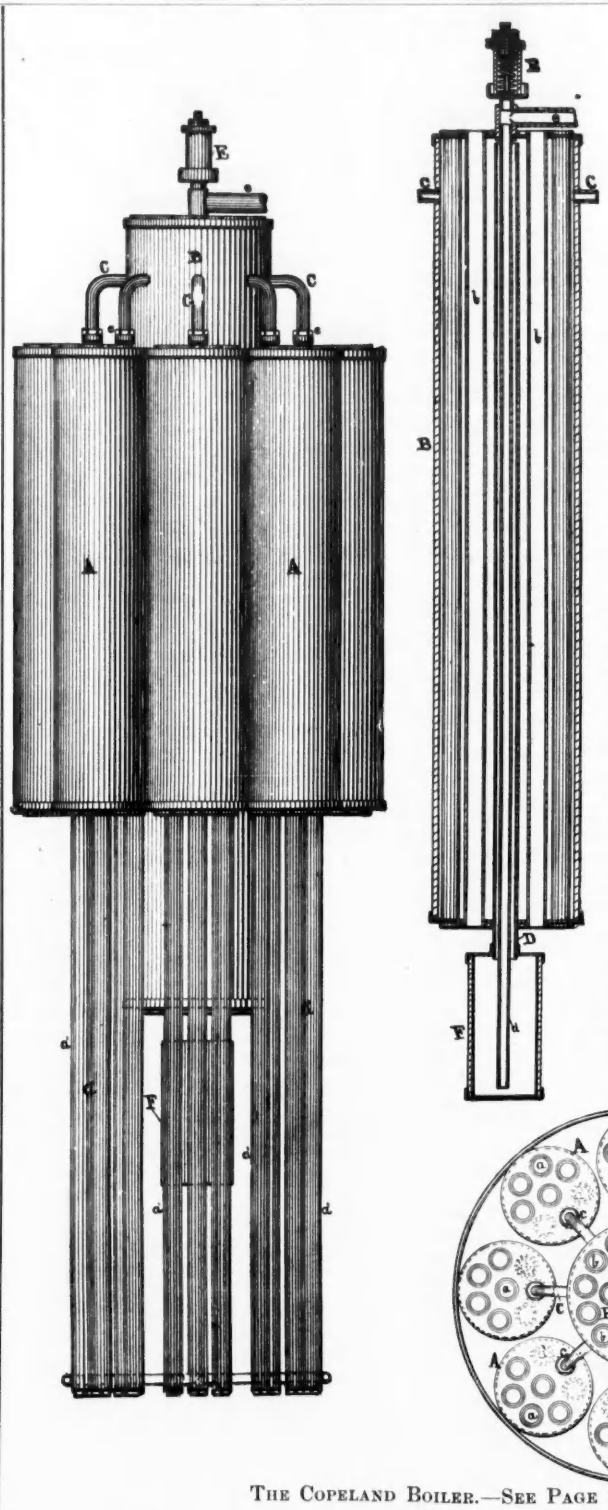
The present revolution in the use of steam must be attended with failure of metals, and until we have a substitute for copper pipes, we must arrange and design them to keep pace with the ever advancing strength in boiler construction.

In the largest triple expansion engines now built, I think the high pressure cylinders are not over 50″ diameter; I believe they usually run from 32″ to 44″, so it is safe to say that a 14″ pipe, with the present single pipe system, is large enough to furnish steam for any of the large marine engines. With the system proposed, we should reduce the area of this 14″ pipe about 30 per cent., or from 154 square to 108 square inches.

I should then put these 108 inches in two pipes, each 8¼″ diameter, or say, practically, an 8″ copper steam pipe, instead of one 14″ diameter. The metal would be $\frac{9}{32}$″ thick. An 8″ copper pipe, properly made and erected, and automatically kept free from water, is safe under 175 pounds per square inch, but a 14″ pipe of copper ⅜″ thick is not safe, as any thickness above $\frac{5}{16}$″ cannot be relied on in sheet copper.

There is only one way to keep pipes, jackets and chests free from water, and that is to return it to the boilers continuously by an independent duplex pump. I was lately on a vessel that had been undergoing repairs, and during her first trial a large stop valve was suddenly opened, sending probably 15 gallons of water, that had collected in the boiler connections, through an 8″ copper pipe, for a distance of 15 feet, and every one standing in the engine room supposed that some portion of the cylinder or chest had been broken, as the shock was terrific. Luckily, no damage was done beyond the springing of a rocker arm on the rock shaft. It was probably the same kind of a blow that split the 9½″ pipe on the steamer Elbe, and therefore my theory is that we should expose as little copper piping surface as possible.

Many copper pipes on board ships are under constant twisting strains, due to improper fastenings, and the manner of leading the pipes. Deck beams and heavy carlings are many times snugly placed in position, without even a thought as to how some important steam pipe is to be arranged to connect the boilers with the engines, and the consequence is that many sharp turns and cramped elbows are necessary in order to complete this connection.



The Copeland Boiler.—See Page 1.

The new ships now building in England and Scotland for some of the well-known steamship companies, are designed to have a central trussed bulkhead running through a portion at least of the engine and fire rooms, and it appears to me that this arrangement ought to provide excellent space for leading the steam pipes.

A straight line of steam piping on board ship would appear to be among the impossibilities, yet I think the proper amount of study will develop some practical plan. A line of copper steam piping with numerous bends and deformities is necessarily weaker than a straight line, because the metal is overworked in making it, and the turns and elbows offer undue resistance, causing serious shocks whenever bodies of water are moving in the pipes.

On the lakes cast-iron steam pipes were once used, but at present copper and wrought iron are the metals. Suppose that we arrange the steam pipes in the manner suggested; if we do not, as I have previously stated, provide means to constantly remove the water from them, we are yet liable to sudden fracture, though the danger is largely reduced by the reduction of the size of the pipes. One source of trouble from water is the usual nest of piping and valves on the top of the boiler. None of the valves in question being tight, condensation is rapidly going on, therefore the valve chambers, pipes and elbows all become reservoirs of water, and if the main current of steam is suddenly started towards the engine, a fracture somewhere at the other end of the line is liable to occur. Another bad feature in piping the boilers and engines of ships is the multitude of small vertical and horizontal pipes leading from the main steam connections to the various steam pumps, donkey engines, etc. These pipes fill with water from condensation, and when the main engines are started the strong current of steam in the main steam pipe lifts the water from these small pipes and carries it instantly towards the main engines. This arrangement is frequently found on small steamships, but it can easily be avoided by having a set of connections on the boiler especially set apart for the steam pumps and small engines.

A little thought given to designing marine steam pipes would prevent a majority of disastrous explosions.

Bicycle with Copeland Engine.

Tricycle with Copeland Engine.—See Page 1.

Shop Notes.

By Jarno.

No. 3.

"It is always telling how to do work cheaper."

We are told that there were once upon the earth animals that are now no longer living. The records left by these animals are called fossils. There are also fossils of animals of the same species as are now living. We may find specimens of animated nature that have been supposed to exist only in fossil.

My acquaintance over the way has found one of them. My acquaintance asked a workman whether he would like to subscribe for a certain mechanical paper.

The workman replied: "No, I do not like that paper."

"If it is a fair question, will you please tell me why you do not like the paper?"

"It don't favor the workingman. It is always telling how to do work cheaper."

How to do work cheaper is a story now often told. Whatever may be the opinions of men as to the benefit of machinery, certain it is that machinery has come to stay. We may name or imagine losses to a few people by the change from handwork to machine work.

There are some thinkers who maintain that inconvenience and pain are as much in the order of things as pleasure. Yet we cannot refuse to carry a watch because machinery enables us to buy it for half the price of a watch thirty years ago. Very likely there are more people, and better paid people, employed in making watches and all other things than there were thirty years ago.

I think we shall make but little headway if we try to stem the mighty currents of that surging sea of activities and of thought comprehended in modern life. This may imply drift. Yet the drift is the direction of progress. When it is necessary to change the current of thought the man of genius will direct. I think he will not refuse to subscribe for a paper because it tells how to produce whatever man wants with less labor.

I think machinery will sometime bring fewer hours of labor for all men. We shall then have more leisure. Leisure brings culture. The word of ambition of to-day is culture.

Modern Locomotive Construction.

BY J. G. A. MEYER.

FIFTY-NINTH PAPER.

COUNTERBALANCE—CONTINUED.

In order to express ourselves concisely in that which is to follow it will be necessary to give a more general definition of the term "lever arm," and also a definition of the term "moment of a force" which we shall introduce.

Fig. 371.—Let $k\ b$ represent a lever, a its fulcrum, R and C weights attached to the ends, k and b, of the lever.

By the term "lever arm" is meant the perpendicular distance from the fulcrum to the line of direction of a force applied to the lever arm. For instance: The weight C when applied to the end b of the lever will act in a vertical line $b\ C$, and therefore, according to our definition, the line $a\ b$, which is perpendicular to the line $b\ C$, will represent a lever arm. The line $a\ k$ represents another lever arm of the lever $k\ b$, because $a\ k$ is the perpendicular distance from the fulcrum a to the line $k\ R$ in which the weight R acts. In fact, we may say—that the lever arm is the shortest line that can be drawn from the fulcrum to the line of direction of the force.

By the term "line of direction of a force" is meant a line indicating the direction in which the force acts; the length of this line is not limited by the distance between the lever arm and the weight attached to it. Thus, in Fig. 372, let the lever on one side of the fulcrum be bent as indicated by the line $d\ a$. In this case the line of direction in which the force produced by the weight R acts, is not limited by the end of the lever d and the weight R, but the line of direction is represented by the line $d\ e$ drawn beyond the fulcrum, so that the line $a\ k$ can be drawn from the fulcrum a perpendicular to the line of direction $d\ e$. In this case the line $a\ k$ is the lever arm of the weight R.

Since the weight R acts with a leverage $a\ k$ we may say that $a\ k$ is R's lever arm, and for a similar reason we may say, that $a\ b$ is C's lever arm.

Moment of a Force.—The moment of a force with respect to a point is the product obtained by multiplying the force by the perpendicular distance from the point to the line of direction of force. When the forces are applied to a lever, then the product of the force multiplied by its lever arm is the moment of that force. Thus:

In our lever $k\ b$, Fig. 371, the force produced by the weight R tends to turn the lever around the point or fulcrum a, and the same thing may be said of the force produced by C, that is, it tends to turn the lever around the same fulcrum a, but in an opposite direction. The weight R acts with a leverage $a\ k$, hence the product of the weight R multiplied by its lever arm $a\ k$ is the moment of the force produced by the weight R. In like manner, the product obtained by multiplying the weight C by its lever arm $a\ b$ is the moment of the force produced by C.

The moment of a force is used as a measure of its tendency to turn the lever around a point, such as the fulcrum a. By establishing this measure of the tendency of a force to produce rotation, we obtain an easy method for comparing the effect of the two forces applied to a lever; that is to say, we can readily determine whether the forces applied to a lever will hold it in equilibrium or not; and if these forces do not hold the lever in equilibrium we are enabled to calculate quickly the amount by which one of the forces must be increased or decreased, and this is exactly what we have to do in counterbalancing a locomotive.

When a lever is in equilibrum the moments of the forces are equal to each other.

To make the foregoing principles clear let us take the following example:

Ex. 72. Suppose that, in Fig. 371, the length of the lever arm $a\ k$ is two feet, and the weight R attached to it 150 pounds, the length of the lever arm $a\ b$ is four feet, and the weight C is 75 pounds. Will the lever $k\ b$ under these conditions be in equilibrium? The moment of the force applied to the lever arm $a\ k$ is equal to the product of the weight R multiplied by the length of its lever arm $a\ k$; hence we have: 150 pounds × 2 feet = 300 = moment of R.

The moment of the force applied to the lever arm $a\ b$ is equal to the product of the weight C multiplied by its lever arm $a\ b$, hence we have: 75 pounds × 4 feet = 300 = moment of C.

Here then we see that the moments of the weights R and C are alike, and consequently the lever must be in equilibrium. Let us take another example.

Ex. 73. The length of the lever arm in Fig. 371 is two feet, the weight R attached to it is 300 pounds; the length of the lever arm $a\ b$ is four feet, and the weight C attached to it is 75 pounds. Will the lever under these conditions be in equilibrium? If not, what change must there be made in the weight R?

The moment of the force produced by the weight R is equal to 300 pounds × 2 feet = 600.

The moment of the force produced by the weight C is equal to 75 pounds × 4 feet = 300.

Here we see that the moment of R is 600,

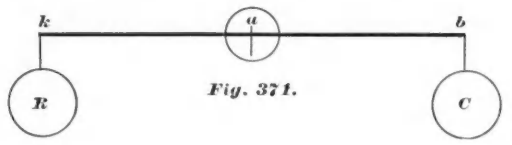


Fig. 371.

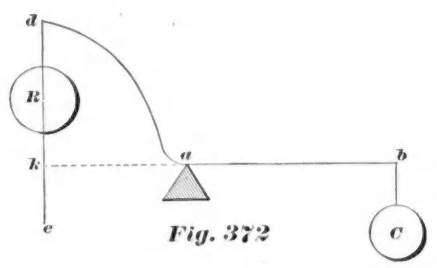


Fig. 372

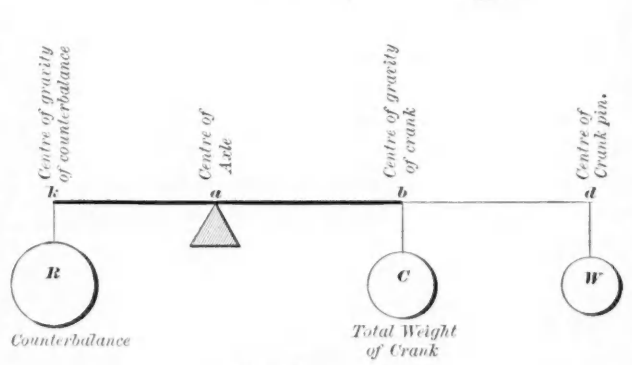


Fig. 373

and the moment of C is 300, and since the moments are not equal, the lever cannot be in equilibrium. These moments also indicate, that because the moment of R is greater than the moment of C, the weight of R is too heavy, and consequently will turn the lever around the point or fulcrum a and pull the end k downwards.

In order to produce equilibrium, we would have to change one of the lever arms, or change one of the weights; but according to the conditions given in our example, we can only make one change, and that is in the weight R. Hence, our next step will be to determine by calculation the amount of reduction in the weight R.

We have seen, that in order to produce equilibrium, the moments of the two forces must be alike. We know that the moment of the weight C is 300, and we also know that the length of R's lever arm is 2 feet; now since the product of 2 feet into the weight R, that is, the moment of R, must be equal to 300 to produce equilibrium, we simply divide the moment of C by the length of R's lever arm and obtain $\frac{300}{2} =$ 150 pounds for the weight of R. Here we see that the weight must be reduced to one-half of its original weight.

In calculating the moments we must always use the same unit of length for both lever arms, and also the same unit of weight for the forces applied to the lever. That is to say, when we multiply the lever arm $a\ k$ in feet by the weight of R in pounds, we must also multiply the lever arm $a\ b$ in feet (not inches) by the weight C in pounds. If we multiply the lever arm $a\ k$ in inches (which we are at perfect liberty to do) by the weight R in pounds, then we must also multiply the lever arm $a\ b$ in inches (not feet) by the weight C in pounds. Or, if we adopt ounces as the unit of measurement for the weight R, we must also adopt ounces for the unit of measurement for the weight C. To make this plain, let us consider the conditions given in Example 73, namely, that the lever arm $a\ k$ is equal to two feet, the lever arm $a\ b$ equal to four feet, the weight R equal to 300 pounds and the weight C equal to 75 pounds. Taking feet as the unit of measurement for the length of the lever arms, we have, for the moments of R and C:

$300 \times 2 = 600$ = moment of R; and
$75 \times 4 = 300$ = moment of C.

Here we see that the moment of R is equal to twice that of C.

Taking inches as the unit of measurement for the length of the lever arms, we have, for the moments of R and C:

$300 \times 24 = 7{,}200$ = moment of R; and
$75 \times 48 = 3{,}600$ = moment of C.

Here, again, the moment of R is equal to twice that of C. Hence we see that, for the purpose of comparing the effects of the forces applied to the lever, it makes no difference whether we adopt feet or inches for the unit of measurement, so long as we keep the same unit for both lever arms.

If these principles are understood, considerable of the difficulty in determining the counterbalance for an engine will disappear.

In our last paper it was seen that in determining the counterbalance for the crank, we simply assumed the line drawn from the center of gravity of the crank to the center of gravity of the counterbalance to represent a lever with the fulcrum at the center of the axle, and then calculated the weight attached to one end of the lever that would counterbalance the total weight of the crank attached to the opposite end of the lever.

As we proceed it will be seen that for the sake of convenience in calculation for determining the total amount of counterbalance required in a locomotive, it is desirable to adopt, in place of the whole weight of the crank applied to its center of gravity, a smaller weight applied to the center of the crank pin, which will have the same effect as the whole weight of the crank applied to its center of gravity. This smaller weight is determined in the following manner:

Ex. 74, Fig. 373. Let a represent the center of the axle, and the horizontal line $k\ d$ drawn through a represent a lever with its fulcrum at a; also let $a\ d$ represent the length of the crank—that is, the distance between the center a of the axle and the center d of the crank pin; b the center of gravity of the crank, C the whole weight of the crank applied to b, and R the weight of the counterbalance applied to the point k coinciding with the center of gravity of the counterbalance. Let the total weight of the crank be 300 pounds, the length of the crank 12 inches, and the distance from the center of axle a to the center of gravity k of the counterbalance 9 inches, and the distance from the center of axle to the center of gravity of the crank, 6 inches; it is required to determine by calculation the weight W applied to the center d of the crank pin; the weight W is to have the same effect or tendency to turn the crank around the center a of the axle as the whole weight of the crank (300 pounds) applied to the center of gravity b.

We have seen in Example 71 (fifty-eighth paper) that to counterbalance the weight of this crank under the given conditions, will require 200 pounds, and this counterbalance cannot be changed as long as the weight of the crank, its center of gravity, and the center of gravity of the counterbalance remain as they are given.

But we have already seen that the moment of a force is a measure of its tendency to produce rotation. The moment of the counterbalance R in our example is equal to $200 \times 9 = 1{,}800$. This moment, 1,800, is the measure of the tendency of the weight of the crank to produce rotation; and if the lever $k\ b$ is to remain in equilibrium, the moment of weight C must also be equal to 1,800, which is the case in this example, for the distance from the center a of the axle to the center of gravity of the crank is 6 inches, and the weight of the crank is 300 pounds, hence the moment of C is $300 \times 6 =$ 1,800.

If we now replace the whole weight C of the crank applied to the center of gravity of the crank by another weight W applied to the center of the crank pin d, and at the same time preserve an equilibrium, it must easily be perceived that the moment of W must be equal to the moment of R. Again, since the moment of C, as we have shown, is equal to the moment of R, we may say that the moment of W must be equal to the moment of C. Therefore, when to the center d of the crank pin a weight W is to be attached, which shall have the same tendency to turn the crank around the center a of the axle, we have, for determining the amount of the weight W, the following rule:

RULE 40.—Multiply the distance from the center of gravity of the crank to the center of the axle in inches by the total weight of the crank in pounds; divide this product by the length of the crank in inches measured from center of axle to the center of the crank pin; the quotient will be the number of pounds in the weight W.

Therefore, the required weight W in our example will be

$$\frac{6 \text{ in.} \times 300 \text{ lbs.}}{12 \text{ in.}} = 150 \text{ lbs.}$$

Generally in locomotives the center of gravity of the crank is not in the center of its length; but the Rule 40 will apply to all cases in which the center of gravity is in the center of the length or otherwise. How the center of gravity in bodies of different form can be obtained will soon be explained.

The advantage of determining the weight W applied to the center of crank pin in place of the whole weight C of the crank applied to the center of its gravity, is, that, the counterbalance for the crank and other parts attached to the crank pin, which must also be counterbalanced, can be found with less labor.

As a result of recent accidents which it was clearly demonstrated were caused partly if not wholly by overwork and excessive hours of labor of enginemen, it has been ordered that no enginemen of the Great Northern Railway, England, shall be allowed to go on duty without having had an interval of at least nine hours' rest. This is a wise provision and one that should be generally enforced, not only for the good of the men, but for the safety of the traveling public as well.

The London *Times* has an account of a small vessel for a mission society in Africa, which is built entirely of delta metal. The vessel is 21 feet long, 7 feet beam, with a depth of 3 feet. For convenience in transporting she was built in three sections.

Practical Details of Blacksmithing.

By B. F. Spalding.

In visiting a manufactory of monkey wrenches some time ago, I saw an arrangement for drawing out the shank, which was, in its essential points, very much the same thing as a punch press. There was a crank connection which moved the hammer head with an arbitrary motion, just so far up and down, at every revolution of the crank shaft, and the stock, placed between the dies to be worked, was forced to be reduced to such size as would permit the die to go as far as the crank would carry it, or the machine had to stop. I watched it for some time with interest. The man who was running it, who was an old hammersman, did not like it. "It rides the iron," he said. Bolt-heading machines generally work on this principle. The header, which staves up the stock, comes up just so far, and the side dies come together just so near, and the stock must yield, or the machine must take the consequences. I have seen quite a number of machines that have evidently taken the consequences.

This plan has been greatly improved upon by the later manufacturers of power hammers by interposing by various ingenious devices, springs, somewhere between the crank connection and the hammer head, so that the crank, or its equivalent eccentric, can make its revolutions, even if the resistance between the dies is too great to be overcome by the power. The spring, by this arrangement, gives, in proportion to its strength, a more or less yielding pressure.

In setting old-fashioned trip hammers, one of the objects aimed at is to make the adjustment in such a manner as to prevent the hammer die from "riding" the piece which is being worked. This means that the die is not to lay on the hot iron, but is to rise from it as soon as the full force of the blow is delivered. In welding under the hammer a little "riding" is allowable, for the same reason that a "dead" blow is sometimes called for when welding "on the anvil" pieces which have a tendency to spring apart. The makers of the modern power hammers have generally provided for this, and the provision they have made should, with great surety, be brought to the attention of the workmen who are to run the hammers. It sometimes happens that this information is sent to their customers, who, not thinking it of any great importance, consign it to the waste basket, and the workman is left to evolve from his own inner consciousness the inventor's design. He sets about this task with a spirit of investigation, a big wrench, and a sledge hammer. Failing to compass it, he finds a world of fault, which is not in the machine itself, but in his want of information concerning it. This could be avoided easily, and with much satisfaction all around.

Even the matter of setting the countershaft at the right distance from the hammer, which any one who paid no attention to it would think of no great consequence, is a thing which the makers well know should be done right, to have the hammer work well. If they do not insist upon such points strenuously it is because they have a reluctance about doing so, lest their customers may run away with the idea that they have no use for a machine which requires to be set up and taken care of with such nicety. It is always the best way to follow, as closely as possible, the builders' directions about their machines. If they do not know about them, who does?

I think that the first machine that I ever noticed particularly, which was absolute and unyielding in its treatment of hot iron, was in Northbridge, Mass. It formed one of a system of machines for the manufacture of scythes, designed by one of the best and most original mechanics New England ever produced—Harvey Waters. The edge of a scythe is very thin in proportion to its back, and the process of thinning it naturally tends to make that side the longest, and give the blade a curve like a sword, concave in the back. Mr. Waters' method of bending it towards the thin edge was by crimping this edge, thus contracting its length, making it shorter, on much the same plan, although for a different purpose, that more recently has been adopted to reduce the circumference of the entering end of a joint of stove pipe. The edge of the scythe blade being shortened, it became the innermost, and the back the outermost of two concentric circles, forming a circular

Fig. 1.

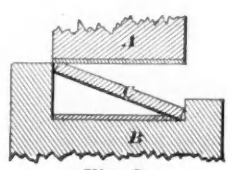


Fig. 2.

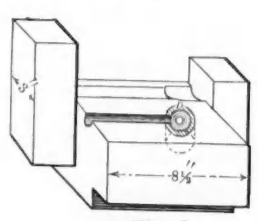


Fig. 3.

Details of Blacksmithing.

ring, of which the blade was a sector. The whole length of this crimped scythe was put between a pair of dies in a very large and powerful press, where the crimps were strengthened by pressure, while the dies did not allow the curve to change. The surplus length was thus taken up, having been, by this means, "upset" or "stove up" The question was asked of Mr. Waters, what he thought the effect would be if he should happen to get more between the dies than the machine could compress? The idea that the machine might break seemed not to enter his mind, he was so sure of its strength. His reply was that the belt would slip.

A manufacturer, having named a rate of speed at which a certain press of their construction should run, the question was asked him if the machine, running at that rate, would stall, or would break, in case more resistance was offered to it than it could overcome. He said the machine would stop, if its blow was not sufficient to carry it through. As it had a large balance wheel, which revolved with sufficient momentum, at a considerable speed, to keep it running a quarter of an hour after the belt was thrown off, I never felt as though I should like to try the experiment. This is a kind of experiment, however, that sometimes tries itself. I heard of its doing so with another machine of the same construction, in a neighboring shop, and the result verified the manufacturer's prediction. It stopped, without breaking.

Very powerful power presses have been used for cold pressing sewing-machine shuttles. A friend of mine related to me that he was once in a shop in Hartford, Conn., looking on to see a man doing this work. When the shuttle, just pressed, stuck to the upper die, the man did not notice it, and neglected to take it off, and put another into the right place in the lower die to receive the blow. The punch responded to the treadle and came down. There was a sound heard, as of a low, dull explosion. The punch went up again. Everything looked as usual. Nothing seemed disturbed; but examination showed that the press had cracked across the throat, and the top had lifted from the bottom by the amount of the thickness of the shuttle. This machine might not have broken if it had been stalled with a solid piece of steel, at half its stroke; but on that last sixteenth of an inch its whole enormous power was thrown through an extent of the circular motion of the balance wheel which very much exceeded that which would have been taken up to carry the punch the same distance at the half stroke, and exerted a force commensurate with this difference. It would appear that some arrangement might be made on these powerful machines, so that, if the burden put upon them was greater than they could bear, they could yield and immediately recover. By this, their efficiency would be increased, for there would then be no risk of putting upon them more than they could bear. It would serve the same purpose as the safety valve on an engine. It should be on the pop valve order; to stand not upon the order of its going, but, when it is forced to go, go at once, and come right back.

In speaking of the effect of straightening the crimps, and by throwing the crooked into a straight line, upsetting the stock, I am reminded of some eye bolts which were to be made of ¾" round iron, as in Fig. 1.

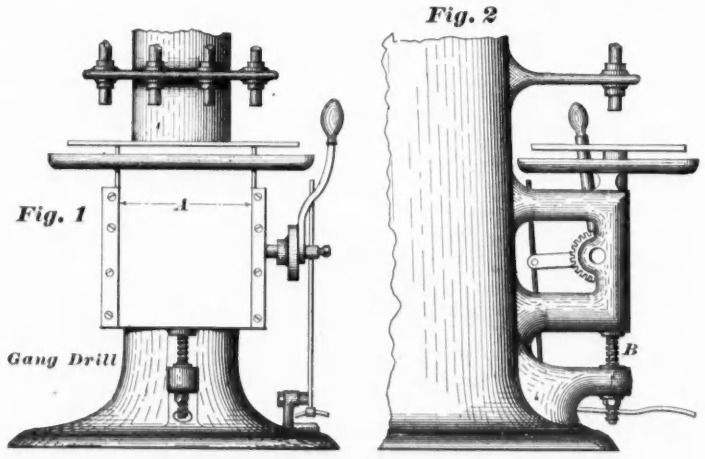
The stock was not large enough to make the eye without upsetting about half an inch, and it was not convenient to use the bolt machine for this purpose. With the bolt header once set for the work, we could probably have headed 3,000 in half a day; and this would have been an economical method, although it would have still been necessary to heat them again to shape the eye. The plan adopted was as shown in the sketch, Fig. 2.

Here *A* represents the upper die in the drop, *B* the lower die, and *C* the piece to be upset. The principle is much the same as that on which the scythe edge was upset. "The shortest distance between two points is a straight line" was the familiar axiom, illustrated by pressing the crimps straight. The crimp would analyze down to two right-angled triangles, and the edge was upset to the sum of the amount of the differences in each between the lengths of the base and hypothenuse of these angles. In the case of the bolts to be made, they were to be 8½" long, after they were upset, and were cut 9" long. We had the base 8½", the hypothenuse 9¼"—allowing for expansion, etc. To find the height of the perpendicular, it was not necessary to figure; for a quicker way was to take a piece of ¾" round iron, and put it inside the blacksmith's square, so that one end did not extend beyond the 8½" mark, and notice how high up the other end extended on the square. By this primitive method it was determined that the backing post should be about 5" high. A half round groove was cut in each die, so that when they were face and face together, the ¾" iron would lay in it, and this groove was enlarged at the end, to allow for the increase in the thickness of the end of the bolt, when it was stove up. As it was desirable to finish to bolts at one heat, the impressions to form the eye in the right shape were made in the same dies. As it was necessary that these impressions should match each other very perfectly, to strike the eyes with sufficient accuracy to be easily trimmed, they had to be made in steel, while the bodies of the dies were easier made, and, to all intents and purposes, just as good, of cast-iron.

Fig. 3 shows the lower die, made of cast-iron. The steel in which the impression for the eye was sunk is shown at *D*. A hole, 2" deep and 2½" diameter, was made to receive it. The cast-iron die was heated nearly red for its reception. The contraction of the cast-iron should take place before the steel has become hot, or, instead of getting tight by cooling, it will get loose, because steel expands nearly twice as much as cast-iron, with the same increment of heat. The post shown at the right-hand side of the figure was for the hot end of the iron to abut against. The top die was of the same shape as the bottom die, minus the posts, which were left off in casting.

The manner of working the eye bolts with these dies was this: A short heat was taken on one end of a piece of round iron, of the right size and length—¾" round x 9"—and it was placed in the die, as shown in Fig. 2, the lower end being the hot end. The top die coming down, drove the 9" piece into the 8½" space, thus staving up the hot end ½". The piece was then lifted over into the steel die and received its impression, leaving a thin fin all around and also across the hole in the middle. They were then thrown down, and, when cool, were taken to the trimming punch and there the fins were removed.

Thus dressed, they made very good looking eye bolts, and were uniform with their fellows. In this respect, as in all others, they were a great improvement over those which had previously been made by hand.



Vertical Drills.

Vertical Drills—Their Construction and Uses.

By John J. Grant.

THIRD PAPER.

But few years ago scarcely any place, outside of gun, sewing machine and similar shops, was fitted up with gang drills. Now, very few, if any, decent jobbing machine shops are without one or more of them—showing that tools which were once considered special are now bought and used as part of the regular machine-shop equipment. But there might be many more of them used with profit. The fact of this class of drills being made heretofore of comparatively small dimensions is no reason that we should continue to do so, any more than we should continue to use the old slide rest lathe of our grandfathers. Jig drilling has, in the last few years, been gradually working to the front, and this makes it necessary, as a general thing, to use several sizes of drills, to obviate the necessity of removing work from the jig until finished. This, more than any other one point, is where the gang drill proper comes in. Bear in mind that what is meant here by gang drill is a drill where the spindles are stationary and the work is raised to the drill, by means of an elevating table, worked by hand or foot lever, or both.

Multiple spindle drills, for use in jig drilling, should have but one table for all the spindles, as the jig can then be moved along its entire length without lifting, which, in heavy work, would be very laborious. Multiple spindle drills, designed for use where more than one workman is expected to run them, should have independent tables, as it would then be necessary to have separate adjustment for each drill. When gang or multiple spindle drills are intended to be used for drilling holes, say, over ¾" diameter, the spindles should move, and the tables be stationary, but should be adjustable vertically. Each spindle should have power feed, and one or two of them should be strongly geared for counterboring, facing or tapping.

The requisites for a good gang drill are about the same as for any other drill, with the addition of a very important feature, which has been overlooked by all manufacturers, or certainly has not come under my notice. That is, an independent adjustment for each spindle, for the purpose of keeping them in perfect alignment, or, more properly speaking, at perfect right angles to the platen or table.

Any one having charge of, or using, a gang drill, certainly knows that, no matter how well made the drill is, or how perfect the spindles may "tram" with the table when new, that after using a few years they are out of line, being caused mainly by the pull of the belt, which is always in one direction.

One great fault in nearly all, and, in fact, I may say all, makes of gang drills, is the extremely short belt from the main pulley-shaft to the spindles. There is, as a general thing, but about 12″ from the center of the upright drum or pulley shaft to the spindles, the driving pulleys on the spindles not averaging over 2½″ diameter. In looking over five different makes of gang drills I find that the average for the length of the lower boxes on the spindles is but 2 5/16″. In my judgment, this length should be doubled. I can see no possible reason for not making them of this length, as, besides the pull of the belt, there is generally a high speed, as well as the eccentric motion of a drill, counterbore, or facing tool, which is almost impossible at times to make run perfectly true.

Another thing I noticed in my examination of the drill, is that those fitted with brass or composition boxes, although not in use as many years and doing work not any harder for the machine, are twice as badly worn as those having cast-iron or babbitt metal boxes.

I have never seen any gang drills with a table stiff enough, or the elevating slide under the table wide enough, where there are more than three spindles, as the same patterns are generally used (with the exception of the spindle head and table) for any number of spindles. This makes too much overhang on the table. In no case should the elevating slide be narrower than the extreme distance the spindles are apart, as in sketch *A*, Fig, 1, (page 4.) As a general thing the tables can be made much stiffer with the same amount of metal by a judicious system of ribbing. The "anvil principle" is not necessary in this case; all that is required is stiffness. As there is no vibration to overcome, or rather prevent, and as the gang drill is made for rapid working, all moving parts should be as light as possible consistent with strength.

The stop or depth gauge should be as near under the center of the elevating slide as possible, and should be as rigid as it can possibly be made, so that no deviation from the standard depth to which the tools are adjusted will occur. This is necessary, as it is often required to face or counterbore to the fraction of the thousandth part of an inch.

Many drills are made having the depth stop so far away from the center of the elevating slide that a little more or less pressure on the hand or foot lever will often vary the distance considerably, making the drill subject to the feelings of the workman.

If made as per sketch *B*, Fig. 2, the (page, 4) variation from this cause is brought to a very slight amount, as in this case there can be nothing more than the elongation of the stop rod.

As mentioned before, one of the greatest faults of the present style of gang drill is in the arrangement of the belting driving the spindles. I would make the belt from the horizontal driving pulley shaft continuous around all the spindles; this could be accomplished by using a round belt, and placing the upright idler drum at an angle to the spindles, so that the belts would run straight on the leading side. This arrangement would do away, in a four-spindle drill, with five lacings, and four short belts.

Improved Plumb Bobs—Improved Adjustable Arbor.

Fig. 1 of the accompanying cuts represents an arbor for small saws or emery wheels to be used in the lathe, and is so made as to receive saws or wheels having different sized holes.

This is accomplished by turning a recess in the fixed flange, into which the shell, which is shown detached, can enter.

Taking the size of arbor designated by the makers as No. 1, for instance, without the shell, the arbor is adapted for wheels or saws having ¼ inch holes; by putting the thimble in place with its largest end inside the fixed flange it becomes a 5-16 inch arbor, and by reversing the shell a ⅜ inch arbor is had. By its use wheels having holes of various sizes can be driven, each having a bearing on the arbor from side to side instead of on one edge of the hole only, as in the case when conical bearings are used.

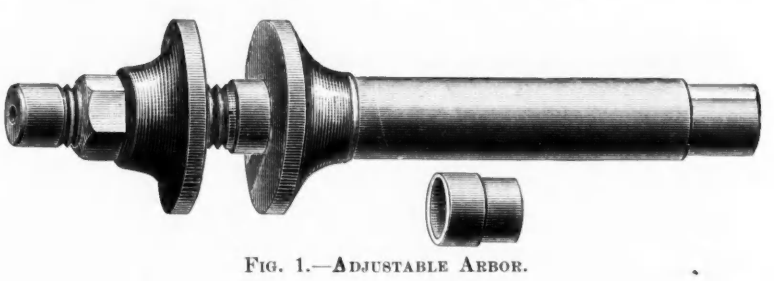


Fig. 1.—Adjustable Arbor.

They are made in four sizes, ranging from ¼ inch to ¾ inch of steel, with finished and hardened nuts.

Fig. 2 shows the appearance and construction of a brass plumb bob, which contains a reel on which the line is wound.

As shown, the axis of the reel is vertical, and it is turned to wind or unwind the line by means of the knurled cap at the top. The line passes from the reel through the small bent tube shown, and thence up through the center of the reel to the ring.

The friction upon the reel is sufficient to prevent its unwinding by the weight of the plumb bob, so that any desired amount of line may be unreeled and the bob supported at any desired height. It has a steel point which the makers state is screwed into place and turned off, thus securing its accuracy. It presents a very neat appearance and weighs 14 ounces.

The makers of these tools, Frasse and Co., New York city, put up a set of 14 plumb bobs of various sizes, weighing from 2 to 16 ounces in a velvet lined tray (Fig. 3) for mechanics and surveyors. This set includes one of the improved bobs with reel, the others being plain with screw caps and steel points.

Fig. 2.—Plumb Bobs.

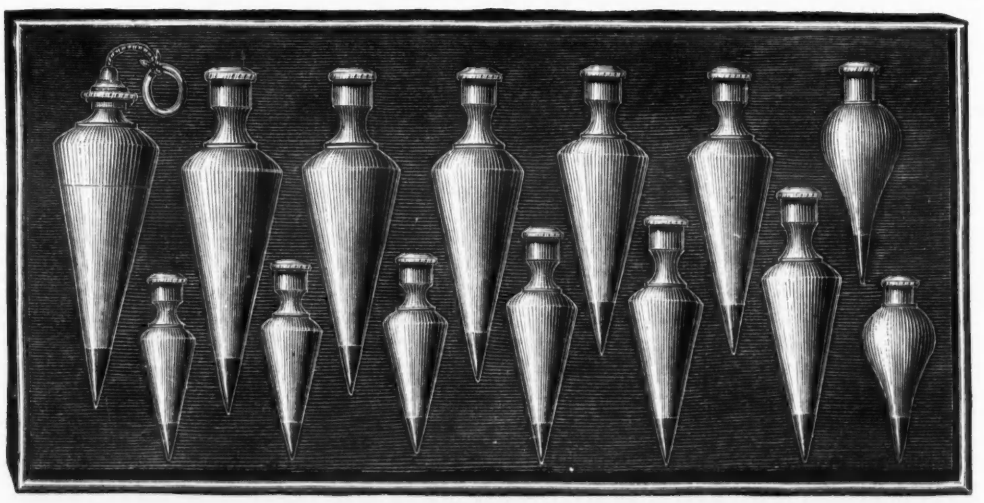


Fig. 3.—Plumb Bobs in Tray.

In England the practice of transmitting power from engine to shafting, has seemed likely to be almost entirely superseded by rope driving. Now, however, by the use of improved machinery for cutting the teeth of spur gears of large size, they are enabled to use much better gears than formerly, and it seems not improbable that there may be a return to the use of gears for such purposes.

Cooper Union had a revenue last year of about $46,000 dollars, which was just about equal to the expenditures. The revenue of this sterling institution should be increased.

An express passenger compound locomotive on Webb's system is now being built by Beyer, Peacock & Co., Manchester, for the Pennsylvania State Railroad. It will be precisely similar to the compound engines now running the main line trains on the London and Northwestern. The two high pressure cylinders, 14″ by 24″, are outside connected and actuate the hind drivers, while the single low pressure cylinder is 30″ diameter, and 24″ stroke, and is inside connected to the main drivers. The two pairs of drivers are not coupled, and are 75″ diameter. The boiler pressure is 175 pounds per square inch. This locomotive is intended for experiment, in order to compare with the best American locomotives.—*The Engineer and Iron Trades Advertiser.*

The Italian Society for the Advancement of Electrical Science offer a medal worth about $150 for the best paper on electro-magnets, considered with a view to their application to dynamos. We imagine that the man who is fortunate enough to devise anything new and of value in this respect named can make a good deal more than $150 out of his invention, and hence will not be likely to give it away. There may be some "best" paper presented, but it is not likely to contain any startling revelations. There seems to be some curious opinions in societies of this kind that crop out in the offering of a few dollars to some one who will make a great invention and then give it away, but that sort of thing is not being done to any great extent nowadays

LETTERS FROM PRACTICAL MEN.

Shorter Hours for Marine Engineers.

Editor American Machinist:

I note an article in the last issue of your paper in which you state that "the marine engineers of New York and vicinity are moving for higher pay." While no doubt this may be true in individual cases, let me assure you that there is no combined movement to attain that much-desired result, but the Marine Engineers' Association have prepared and presented to Congress a bill limiting or regulating the hours that a marine engineer shall remain on duty. This bill has met with much favor, and no doubt will become a law, as we only ask that our hours of labor shall not exceed 12 in each 24 hours.

Aspinwall Fuller,
National President Marine Engineers' Association, 287 Hudson st., New York.

Tests of Materials.

Editor American Machinist:

Reviewing John Coffin's paper on Car Axles, read before the American Society of Mechanical Engineers, brings up an odd notion which I have been pondering over for a long time, and the results of his treatment of this particular piece of structural steel makes it possible to test the value of my notion in a conclusive manner.

But, first, I should like to suggest a method of testing axles, more extensive, so far as I know, than any that has yet been applied.

As appears from Mr. Coffin's paper, axles treated in the way he describes now stand 50 blows of the drop as well as axles direct from the forging will, five. If, as the test would indicate, the axles are ten times as good as those heretofore made by the same company, and which the Pennsylvania R.R. have been in the habit of throwing out after a given number of train mile tons work, then the question naturally arises, will they stand ten times the duty that has heretofore been considered the safe limit? To settle this as conclusively as can well be done, I would suggest this plan: Take 100 of the treated axles, and test to destruction five axles, selected indiscriminately, then run the remaining 95 to the limit of use now considered safe. Then take the first five that reach the limit, and test them to destruction, and if the number of blows this second five stand show a marked falling off, continue the 90 in use, say half as much longer, and so on, destroying five axles at a time until the whole one hundred are used up and in this way not only determine the safe limit, but also whether the line of deterioration by use is a straight line or a curve.

It would seem from the work done, as reported by Mr. Coffin, that the product is absolutely reliable, and that, except from the fact that flaws may exist, there is no need to subject the axles to any test whatever. If this is true, the test must be nearly useless, from the fact that there is only one chance in a hundred that they will take the axle with the flaw for the test axle. In view of this, would it not be a better plan to test every axle enough to determine whether there is a flaw or not?

Assume that the safe limit of the axle is only 50 blows of the drop, and each axle be given two, would not this, in a large majority of cases, detect the flaw, if one existed? And if none appeared there would be nine times the endurance left in the axle that is now supposed to exist in the untreated sort.

Carrying this idea to its natural conclu-

sion, how much worse would the practice be if every piece of bridge structure that is subject to tension was strained to a point just beyond the elastic limit, than the present practice of allowing a factor of safety of five or six, for fear there may be a flaw in the stock which cannot be detected by observation?

Unless stock of all kinds needed for structural purposes can be made with the absolute certainty that flaws do not exist, and if straining work to a point just past the elastic limit will determine to a certainty that no flaw does exist, then it would seem that a factor of safety of three, when it is known that the material is perfect, would be better than a factor of six, with no knowledge of what uncertainties might be cencealed. The whole thing turns on this poict: Will a piece of metal, when once strained beyond its elastic limit go to pieces particularly more rapid than if not so strained? John E. Sweet.

Slag in the Cupola.

Editor American Machinist:

In reading over your "Questions and Answers" column, Feb. 18, I noticed that G. P., of Norwich, Conn., writes that he has more slag when the tap hole is too large, and that L. C. Jewett says the slag is there the same, whether the hole is large or small.

I find in my experience that the blast has a great deal to do with it. If G. P. will notice his blast in furnace he will find that the wind varies. Now, if he will notice, he will find that on the day he has the most slag he has the most wind, and he will find by gauging he has too much. If you are using good clean iron every day, and have a great quantity of slag to-day and not very much to-morrow, it is the blast that is the cause. Too much wind makes slag. J. H. DeNeep,

Foreman Stiles & Parker Press Co., Middletown, Conn.

Transmission of Heat Through Thick and Through Thin Plates.

Editor American Machinist:

There is a popular idea, even among experienced engineers, that the thickness of metal in a boiler has a decided effect on the rate of evaporation—thin metal transmitting the heat of the fire more rapidly than does a thicker material. For example, here is a statement taken from the catalogue of a well-known water tube boiler:

"The thick plates necessarily used in ordinary boilers, in the furnace, not only hinder the transmission of heat to the water, but admit of overheating, and even burning the side next the fire, with consequent strains, resulting in loss of strength, cracks, and tendency to rupture. Water tubes, however, admit of thin envelopes for the water next the fire, with such ready transmission of heat that even the fiercest fire cannot overheat or injure the surface."

Another example of the same idea is found in one of the numerous technical "Catechisms" which are offered to engineers. It is as follows: "The advantage of thin tubes is that the heat inside of them is conducted to the water outside more rapidly than it would be through thicker metal, which is important when combustion is so rapid as it is in locomotive boilers."

Of course there must be some foundation for this idea, and it seems to be derived from Peclet's experiments, the law established by that experimenter being given in D. K. Clark's "Rules and Tables," as follows:

"The flow of heat which traverses an element in a unit of time is proportional to its surface, and to the difference of temperature of the two faces perpendicular to the direction of the flow, and is in the inverse ratio of the thickness of the element."

The foregoing quotations present, it is believed, a fair and full statement of the views entertained by the advocates of thin plates for boiler construction, with the authority for those views. It is now in order to give the other side of the question.

Peclet's experiments are ably discussed by Prof. Rankine, in his "Manual of the Steam Engine," and, as frequently happens in such cases, the reasoning of the latter has thrown new light upon the conclusions to be drawn from the experiments. After an analytical discussion of the subject, Prof. Rankine adds:

"The external thermal resistance of the metal plates of boiler flues and tubes, and other apparatus used for cooling and heating fluids, is so much greater than the internal thermal resistance, that the latter is inappreciable, in comparison, and, consequently, the nature and thickness of those plates has no appreciable effect on the rate of conduction through them."

Experimental proof is always valuable in the determination of any question, and, fortunately, such proof is available in the present case, the experimenter being Prof. Walter R. Johnson, well known as an experienced and careful observer. A work by Prof. Johnson, entitled "Notes on the Use of Anthracite in the Manufacture of Iron, with some Remarks on its Evaporating Power," contains the following passage:

"Mr. Parks lays considerable stress upon the thickness of metal of which a boiler is composed, as influencing the rate of evaporation, and also on the temperature of combustion, as affecting the durability of boilers. In regard to the former of these points, I may mention that my own experiments on iron of different thicknesses, from $\frac{1}{50}$ to $\frac{1}{4}$ of an inch, and those of Mr. Hayes, from $\frac{1}{8}$ up to 1 inch, prove that within these limits, which are, in both directions, far beyond the requisitions of the steam boiler, no sensible difference will be produced in the evaporative effect of fuel. And with respect to the second point, I would refer to the fact, first established by my experiments, published some years since in the *American Journal of Science*, and since reproduced both in England and in this country, that, so long as water is in contact with iron under atmospheric pressure, the metal will not receive a temperature much more than 100° Fahrenheit above the boiling point; for, from 312° to 324° is reached the temperature of maximum vaporization—a rate of generating steam far beyond the practice even in locomotive engines." (It is to be noted that this was published in 1841.)

The above quotations, to say the very least, throw considerable doubt upon the positive statements about the effect of thick plates; and, unless the advocates of thin plates can offer proof to overthrow the analytical and experimental results of Professors Rankine and Johnson, it might be well for them to be less dogmatic in their assertions. The subject is an interesting and important one. Perhaps some of your readers can furnish additional facts or data.

New York. Richard H. Buel.

An Air Pump Difficulty.

Editor American Machinist:

I have noticed, for the past seven years, as a constant reader of your (to me) highly valued paper, the courtesy with which you answer questions on mechanical subjects.

I am in trouble, and would like, if possible, to receive light. Will you please give your readers a chance to solve the following problem, as some of them may at some time have been in my fix, and came out all right: A short time ago I overhauled three Westinghouse air pumps—boring out cylinders and renewing all movable parts. Two of these worked well, running smoothly and compressing air rapidly. The third, however, sent me down a well the depth of which I have yet not been able to find. The circumstances are as follows: The pump, when given steam, started working a good even stroke each way, but had a pound on the bottom head. It will run 15 minutes before it can get up a pressure of 80 pounds. Right here is where the trouble begins. I have had the air cylinder off three times to see that no waste or foreign matter kept the valves from seating. The second time I worked on this pump the valves were tested in this manner: The strainer was taken off and a piece of sheet rubber was held before air inlet; this the pump drew up and held tightly; still the pump kept going just as if it was getting all the air it could draw. The rubber staying fast to air inlet assured me that receiving valves were tight, as any blow back would naturally have caused vacuum to cease, and the rubber fall to the ground.

The discharge valves were next tested by taking down bottom head to air cylinder while there was 25 pounds pressure in pipes, and consequently against discharge valves; a lamp was held under lower discharge valve, but it was not leaking; with a stick the top receiving valve was lifted; there could not be felt or heard any leak from upper discharge valve, so I concluded it was tight; the air was then allowed to escape by raising the bottom discharge valve. I then thought in this line: Valves tight and proper lift the pump does not slack down, although all possibility of its getting air is cut off. Conclusion: Piston rings too loose; so they were taken out and pened; result, no better. A new and larger pair of rings were put in, and before the cylinder was put up to its place this piston was shoved down about seven inches; water was poured into the cylinder and let stand for awhile. A leak of 20 to 25 drops per minute was all; this I considered a quite good result for piston packing, such as is used in air brake cylinders. I now had big hopes; put everything up right, after, of course, first removing the water from the cylinder. The pump was tried, but found no better; now I was beaten. I gave the pump a bucketful of potash and several buckets of water, all of which went through the pipes all right, showing that they were open. A close examination was then made for leaks of any kind; everything was tight.

Now what I wish to know is, what is the trouble, or where to look for defects? To me at present it seems like a mechanical impossibility for a pump not to work when it is tight everywhere and gets free admission to the air.

The engine on which this pump is has gone on another division of the road, so I cannot trace the difficulty now, but would be glad to hear from some of our bright air pump repairers. C. A. G.

Milling versus Planing.

Editor American Machinist:

Mr. F. L. Johnson makes some statements in his remarks on the "Relative Cost of Milling and Planing" that seem rather broad. For instance, he says, "Any work that can be done on a planer can be done as quickly and as cheaply as on a milling machine."

In this statement Mr. Johnson is certainly wrong, unless he considers plain surfacing the only proper planer work, and all irregular and complicated forms proper milling machine work.

We have a double-head milling machine that runs two 14″ face mills at a feed of $1\frac{1}{2}$″ per minute, on cast-iron, cutting full width, or 42 square inches of surface finished per minute. While Mr. Johnson can get as much work out of a planer as any one, I doubt very much if he can finish 42 square inches per minute on a planer.

There is another advantage in the use of the double-head milling machine. After setting the machine for a certain piece, almost any number can be put through without further measurements or setting. The gain in readily duplicating work, which is secured by the use of the milling machine, is one of its greatest advantages, especially as the milling machine will duplicate almost any form, however complicated. In this the planer fails entirely. It is true that the milling machine has been used on small work almost exclusively, but the time is approaching when it will be used on almost all medium sized work.

Mr. Johnson further says, "On general shop work, engine, sawmill and mining machinery, where most of the work is heavy and plain, the rotary cutter cannot compete with the reciprocating one."

Some time ago I visited a large engine shop, where all cross-heads, slide-bars, pillow-blocks, connecting-rods, connecting-rod brasses and straps were finished by milling, and where the economy was so manifest that several more double-head machines were being put in to do the remainder of the planer work on the engines.

We are making a gang of six mills, 17″ diameter, to do a piece of planer work, and, when completed, will send a blue print showing cut taken, and the time on the planer and milling machine respectively. This I believe to be the only way to come to a fair conclusion.

The chief reason, in my opinion, that the milling machine is not used more extensively on heavy work is this—the proper machine has not been put on the market.

The average milling machine has a spindle much too small, the table is too shallow, the bed is weak, the driving power fails on heavy cuts, and the feed is a complete failure.

There are machines, however, which lack enough of the above features to show what may be expected when the milling machine is redesigned and adapted to heavy work.

We are getting out a cutter, with which I think it would be possible to mill 100 racks in less than 90 hours. It is a spiral mill, 17″ long by $3\frac{3}{8}$″ diameter, made from a solid bar of steel, and driven from both heads of a double milling machine.

For milling racks the direction of feed would be across the rack instead of longitudinally, as in Mr. Grant's case. Assuming the rack to be $1\frac{1}{4}$″ inches square, and the feed to be 2″ per minute, the right kind of a man could make the 800 cuts in ten hours.

Milwaukee, Wis. C. M. Conradson.

Ice in a Steam Pipe—Domes on Boilers.

Editor American Machinist:

Over thirty years ago I had a steam pipe freeze up. It was a 4″ pipe attached to a safety valve casting on shell of boiler. The boiler was domeless. The pipe ran horizontally about ten feet, and then turned down to the steam chest about four feet. On top of the chest was a slide throttle. The pipe was full of ice from the throttle to within three feet of the safety valve, with ninety pounds of steam. When I wanted to start I could not move the throttle. I took a pail and drew water from the gauge cocks and poured over the throttle box until it was hot. I then opened the throttle a very little and poured hot water on the frozen pipe the whole length of it, and in ten minutes the column of ice was smaller than the inside diameter of the pipe, and the steam rushing through thawed it so quickly that a man would not have time to get "tired."

I have thawed out miles of frozen water mains, from 6″ upwards, in this way. I had a small boiler on wheels; I would dig down to the pipe and drill a hole in it, say the size of a $\frac{1}{2}$″ gas pipe. I had a piece of $\frac{1}{4}$″ lead pipe, with one end attached to the boiler. The other end I would insert in the hole, turn on steam, and keep the end of the pipe close up against the ice. The water would flow back and discharge through the hole. In this way I could thaw 100 ft.(50 ft. each way) without moving. No pressure of steam will melt the ice in the pipe if there is a cushion of air between the steam and the ice. If the air could be drawn off, and the pipe is in such a position that the water will run back, the steam at any pressure will soon melt it.

About domes or no domes on boilers. In 35 years' experience I have handled all kinds. I prefer a dome on a single boiler, and a good sized drum on a battery of boilers. They should, of course, be well protected with some non-conducting covering. It gives a storage for steam, and if you have to crowd the boiler it will carry water better. I like a mud drum for several reasons. First, if properly set, it gives some heating surface. If it has a large neck you can wash everything into it, and get your scale, etc., out better. In the olden time, when boilers were made 28 feet long, and only a small hand-hole to work from, a mud drum came in handy.

Many years ago, I set up a combined flue and tubular boiler to supply an engine 36″ ×

36″, making 60 revolutions per minute, cut-off one third stroke. The boiler was eight feet diameter and sixteen feet long. The steam pipe was ten inches diameter, and connected to a manhole casting directly on the shell. The center of the steam pipe was about three feet above the water line. She would raise her water sometimes, and would pump two gauges of water out of the boiler before I would have time to wink comfortably. Closing the throttle was the only way of breaking the syphon. We then put on a dome, and had no more trouble.

Still, neither a mud or steam drum are an absolute necessity. The dry pipe that Mr. Beaton speaks of was used many years ago by some locomotive builders, but after trying the holes on top, they changed them to the bottom of pipe, and thought they got drier steam L. C. Munger.

Removing Iron Turnings from Babbitt Metal.

Editor American Machinist:

If A. B. C. will melt his babbitt in a large ladle, he will find that the most of the iron turnings will be on top, and can be skimmed off, after which take a small raw potato, put on the end of a stick and stir the metal. The moisture in the potato will cause the metal to boil and bring all the impurities to the top. C. A. Lawton.

De Pere, Wis.,

Trouble with an Inspirator.

Editor American Machinist:

Being a subscriber to your valuable paper, any of your many readers would confer a favor by helping me in the following, which has puzzled me very much. Last spring I placed the engines in a barge for a friend of mine. As there was nothing but the pump for feeding the boiler, which was very inconvenient while laying at a dock, necessitating the working of the engine to feed the boiler, I advised him to get an inspirator, which we got and placed in position. On starting it up, while laying at the dock we found it to work admirably, but when running light at the rate of seven miles per hour, drawing six feet six inches of water, we find that the inspirator will not work. While running at the rate of three miles per hour, loaded, drawing seven feet of water, we find that it will work. The water pipe for feeding the inspirator is taken from a two-inch pipe which goes through the bottom of the barge, which is flat-bottomed, and stands four feet high, forming a stand pipe, the connection being made three feet down from top of stand pipe. The feed pipe proper to inspirator is one inch diameter; steam pipe to inspirator three-quarter inch diameter. The inspirator also fails to work if the barge is rolling much in a sea. The feed water for the feed pump is taken from the same stand pipe.

Can any of your readers explain the cause of the inspirator failing to work?

Duncan McFarlane.

[In our experience in such matters your stand pipe is altogether too small. When the barge is in motion the conditions are much the same as if you projected a stream of water across the open end of the pipe, the tendency being to prevent the water from rising in the pipe as fast or to as great a height as it otherwise would. It also makes the rise of water in the pipe unsteady. The pipe clear through should be larger, but the fact that you can feed when drawing 7 feet of water, and hence have a larger body of water in the stand pipe, indicates the probability, that if you increase the size of the pipe in the barge to 4 inches, or better still, to 6 inches, you would be able to use your inspirator. If the pump fails once in a while a stroke, to get a full supply of water it will go on working, while such a failure will be likely to stop the inspirator.]

Just now it seems to be the powder mill that is dealing destruction around. It would be a very good idea, indeed, if powder mills could be put under a better system of inspection. About one explosion a day appears to be the average lately.

PERSONAL.

J. D. Campbell, for some years general foreman at the elevated railroad shops in this city, has been promoted to the position of superintendent of transportation on the same roads. Mr. Campbell is one of the best railroad mechanics in the country, and is as well a man of rare executive ability. This latter qualification fits him for his present position, which he is sure to fill with satisfaction, but it seems, in a mechanical sense, too bad to remove a man of his ability from the mechanical department of a railroad.

Boiler Inspection.

By Jesse L. Camric.

Writing for a paper must be a business, and one that must be learned as other kinds of business are learned, before a man can expect to make a success of it. But I have observed that the thing we care most about, after all, is what the man has to tell, or the ideas he has to advance—and so, thinking there are things about boiler inspection that ought to be said, I shall try to say them, without expecting to do it in anything like an attractive manner.

My mind has been directed to the above subject by the persistent importunities of certain agents, and a special remark from one, who said he hoped a certain boiler would "blow up," as it would put thousands of dollars in the pockets of his company. Referring to a boiler (I think in some place in New York State) which exploded last summer, he said it had led to their writing policies to the extent of a half million of dollars.

Cogitating over this remark, the thought occurred: If the agent was so anxious for an explosion, how anxious would the inspector, working for the same company, be to prevent it?

Some recent reports in the papers set forth the fact that a certain boiler insurance company has a large surplus on hand and has doubled its capital stock. Why a company who has a large surplus need to increase its capital stock—unless it is to make the dividends look smaller—would seem a sort of mystery to men not conversant with the insurance business. But what does this large surplus mean? That those who insure with the company, and meet with a loss, will be paid, which is good. It also means that those who have insured with the company heretofore have paid a great deal more than it was worth, which is bad.

I remember of having read years ago about an association somewhere in England, (Manchester if I recollect correctly) where boiler users combined to prevent boiler explosions, and after a long number of years, and with hundreds of boilers in use, no explosions had ever occurred. Is not this a better plan?

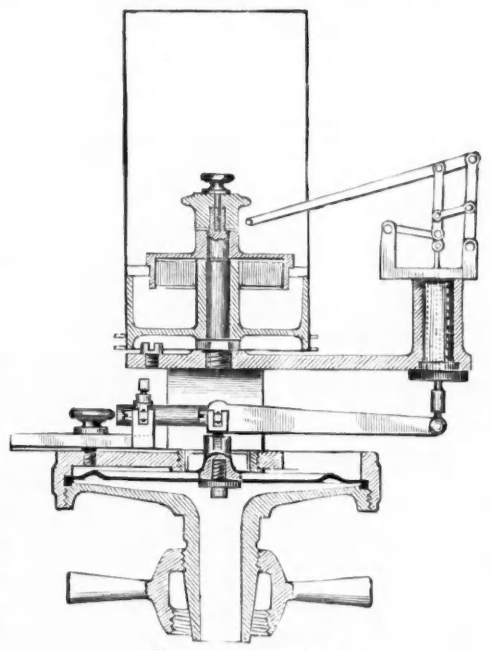
The remark of the agent above quoted shows conclusively that it is to the interest of the boiler insurance companies to have boilers explode, contrary to what at first sight would seem to be the fact, while in the case of the Manchester (if it was the Manchester) association, it proved to be to their interest to prevent explosions. If I remember, it was their practice to give thorough inspection both of boilers and engineers.

There is one other feature connected with boiler insurance that seems to need some sort of vamping over. The agents to a certain extent, and the inspectors to a large extent, have opportunities to gain a first-rate knowledge of different builds of boilers, engines, pumps, injectors, etc., and that knowledge ought to be of value to those about to purchase such things. No doubt they are often consulted on those points, and give valuable advice, and when this is done, the man who receives the benefit should pay the commission, rather than the man who sells the boiler, engine or pump.

As it is now, there is a good deal of uncertainty in the mind of the builder as to whether the boiler inspector's influence was of any value. The inspector may recommend the boilers of a half dozen builders, the one who pays the largest commission, or none at all, and demand the commission all the same. The builder knows he has got to pay or the inspector will knock him out altogether. It is true that it is not the fair thing to do to condemn a system or practice without suggesting a better one for its place, and I have nothing better to suggest than that the insurance companies insist that their employes get the pay for their advice from those who receive the benefit of it.

Brown's Indicator.

This indicator consists essentially of a pressure chamber in which is removably secured a metallic spring diaphragm; to the center of this diaphragm is secured a forked-shaped piece supporting a torsion bar; this torsion bar, made of tempered steel, passes through and is secured to a multiplying lever, at one end of which is a ball and socket joint to which is secured the parallel motion. The other end of the multiplying lever is adjustably mounted in a second torsion bar, which is similar in construction to the bar mentioned. These torsion bars are a special feature of this indicator, and by their use friction and lost motion are eliminated.



Brown's Indicator.

It will be noticed that the first friction joint is at the end of the multiplying lever, and as to this joint the motion of the diaphragm is transferred without error or friction, we may consider it as a point corresponding to the piston in piston indicators, and the only possible friction in the mechanism of this part of the indicator is in the parallel motion.

The torsion bar at the end of the multiplying lever is held in an adjustable slide. This slide is graduated on the side to the various scales used, and to change from one scale to another it is only necessary to adjust this slide. As all of these adjustments are by clamp joints, no lost motion is introduced by their use. This construction appears to be a novel one, and it is evident that no binding or friction can occur.

Directly over the center of the diaphragm is an adjustable stop. The office of this stop is twofold. First, it offers a stop in case of excessive pressure. But it is introduced for a different purpose, namely, to show the action of the exhaust valves to better advantage. To accomplish this the stop is screwed down until it is nearly in contact with the diaphragm, and, of course, limiting the diaphragm motion. It will thus be seen that the lower portion of a diagram may be taken to a greatly enlarged scale, from which the action of the valves can be better studied. It is also convenient, when indicating compound engines, as the exhaust line of the high pressure cylinder, and the steam line of the low-pressure cylinder can be taken to the same scale, when a quick comparison can be made. The space in the pressure chamber is made quite small, so that very little steam is required to fill it.

The drum is of the usual form, and is placed directly over the center of the diaphragm. This arrangement makes the indicator compact and symmetrical, and of light weight.

In the arrangement of the mechanism in connection with the diaphragm, it is seen that the motion of the diaphragm is entirely independent of the scale used. It is customary, when indicating high-speed engines, to use a stiff spring, with a consequent reduction of the height of the diagram taken; this, of course is not desirable. With this arrangement a reduction of the size of a diagram is only necessary at extremely high speeds, as, we are informed, an application of the indicator to engines varying in speed from 50 to 350 revolutions per minute shows that it makes but very little difference, so far as the smoothness of the diagrams go, whether the card is one or two inches in height. It is to be understood that the diaphragms are made to read as correctly as the best indicator springs of other form.

The indicator is provided with an improved "lead" pulley, adjustable pencil stop, etc., and is adapted to be attached to the engine in the usual manner.

It is proposed to use a parallel motion made of aluminum, with joints of steel, hardened in the usual manner.

The inventor of this indicator is W. F. Brown, 21 Harkness street, Providence, R. I.

Literary Notes.

THE ENGINEER'S CATECHISM. A PRACTICAL Treatise for the use of those in charge of Steam Plants. By George L. Fowler. Published by the American Railway Publishing Company, New York.

Engineers' catechisms have been somewhat numerous of late, still we think there is room for this little book. The author has gone about his work in a practical manner, and has shown his good sense by not propounding useless questions for the sake of showing his ability to answer them. The book is not, we assume, calculated to instruct experienced engineers, so much as to assist those who have not had very extended experience in the mysteries of caring for steam plants. The price of this book is only 50 cents.

LITHOGRAPHERS' DIRECTORY. A DIRECTORY for Lithographers, Photographers and all allied arts and trades in the United States and Canada, Mexico and South America.

This Directory is said to contain a complete list of the latest procurable addresses of all firms in any respect connected with lithography, photography, or the graphic arts or allied trades in the United States, Canada, Mexico, and Central and South America. We should think it would be a valuable work of reference to those interested in such matters. It is published by the Lithographer Publishing Co., 12 Center st., New York, and sold for $3.00.

The St. Louis *Lumberman* is the name of a new monthly paper devoted to the lumber, saw-mill and wood-working interests of the West and South. It is published by the *Journal of Commerce* Co., St. Louis, Mo., at one dollar a year. The first number presents a very creditable appearance, and is full of matter of interest to those in the lines of business it covers.

The Shoe and Leather Reporter Annual for 1888 is a book of more than 500 pages, containing a directory of the tanners, boot and shoe manufacturers, dealers in boots and shoes, leather findings, hides, skins and wool, and shoe machinery of the United States, and the principal ones of the Canadas and Europe. For those in these lines of business it is doubtless a valuable book. Published at 17 Spruce street, New York, by the *Shoe and Leather Reporter*.

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The Advantages of Skilled Inspection.

During a recent conversation with a gentleman who has invented and is introducing a new device for the improvement of steam plants, he mentioned the pleasure and satisfaction experienced by him in dealing with men capable of discrimination in such matters, as contrasted with the annoyance often experienced in doing or attempting to do business with those not so well qualified to judge of the merits, absolute and comparative, of his invention.

This invention, which, by the way, is a very good one, is, from its nature, most readily understood and appreciated by those who understand the principles governing the generation and use of steam. When such a man is encountered he only needs to be shown that the device will perform certain functions for which it is designed, and is so constructed that it will infallibly continue to perform them, to convince him of its utility; the advantage to be derived from the performance of those functions being as well understood by him as by the inventor himself, no discussion upon that point is necessary, and no fear of being swindled stands in the way of doing business.

In decided contrast to this is his experience with owners or managers not familiar with the principles involved, and who, in their innocence, have been repeatedly deceived by extravagant claims made in behalf of various devices, which afterward proved to be of little or no practical utility, and where the prejudice naturally resulting from such experience had to be encountered. Not being capable of discriminating between the good and the bad in engineering matters, they naturally placed his device in the same category with those by which they had in the past been disappointed, with the result, frequently, of depriving themselves of decided benefit, and our friend of business which he was justly entitled to.

With large concerns employing engineers regularly, or who make it a rule to refer such matters to competent consulting engineers, no trouble whatever was encountered—such men taking the whole matter in hand, deciding as to the advisability of adopting it, its proper application to their particular requirements, whether or not it was worth the price asked for it, and furnishing correct and complete data for the guidance of the makers in adapting it to the particular case.

There is no doubt whatever of the advantage to be derived by the employment of competent men to investigate such matters in the interest of the purchaser, but the advantage to those who seek to introduce new inventions of merit, is not so often considered. We believe it to be a good practice, beneficial both to those who sell and to those who buy, and that its more general adoption would result in far less dissatisfaction and trouble between manufacturers and their customers. No one seeking to introduce a new engineering invention should hesitate to have it investigated by an engineer of well-known ability and honesty, and a refusal to submit to such examination might be taken as very good evidence that the device would not bear it.

The report of the Board of Mediation and Arbitration of the State of New York is largely taken up with an argument to the effect that the State should interfere to prevent railway employes from leaving their positions, because if they do so it is likely to incommode the public. It is claimed this would be only right because the State holds railroad corporations to an accountability for failing to furnish the public with reasonable facilities.

The State does not nor cannot exact an impossibility of a corporation, which is something the officers of the board seem to forget. Moreover, the State has surrendered nothing to the men in consideration of their working for a railroad corporation, but it has given certain rights of the people to the corporation. Of course any talk of compelling operatives to continue working for a railroad corporation is without sense, unless slavery is to be re-established. But there is no question that the quitting of a large proportion of the men on a railroad is likely to seriously inconvenience the public; hence, if some means of settling all such disputes by arbitration could be brought about by the force of public opinion, it would advantage the public, and probably benefit both the railroad corporations and the employes. Public opinion, based on principles of even justice, can do a good deal in this direction, but if it were possible to legislate men into holding positions in railroad operating against their will, the service would quite likely be highly unsatisfactory, as well as extremely dangerous to the traveling public.

We publish elsewhere in this issue a communication in regard to boiler inspection. The communication is from a man who has facilities for observing that which he writes about, and hence is entitled to consideration. We have no reason to doubt any statements he makes, but at the same time it is due to ourselves to say that we do not believe that the management of boiler insurance companies would for a moment countenance such action on the part of their agents as is detailed, and hence, no doubt, they would, in every instance, be glad to have their attention called to the matter. Practice that is not right nor defensible is likely to creep into any large business, and the surest way to bring about a reform in abuses is to point them out.

To a few individuals in this country there is a fascination about lawlessness that is hard to understand. For example, Theodore Roosevelt, in the *Century*, in an article in which the cowboy plays a prominent part, extols him at the expense of people who attend to their own affairs without troubling their neighbors. After stating that the cowboys ride "their horses into the saloons, firing their pistols right and left," which he says is the effect of "boisterous lightheartedness" and "weeks of brutal dissipation" or the "villainous whiskey of the frontier towns," he concludes: "They are much better fellows and pleasanter companions than small farmers or agricultural laborers; nor are the mechanics and workmen of a great city to be mentioned in the same breath."

This last declaration appears to be just a trifle strained, but the meaning is apparent enough. Our tastes and inclinations are doubtless largely a matter of education, and it is fortunate that the education of a large majority of the people is such that they will continue to see something more worthy of commendation in the behavior of industrious people who obey the law, even though they be "small farmers," "agricultural laborers," or "mechanics and workmen," than in that of those who defy the law as the result of "weeks of brutal dissipation." It is an excellent thing, indeed, that morbid sentimentality in this respect is not likely to become epidemic.

Still, there are those who are influenced by such writing. It is hard to understand wherein it is any better than the dime blood and thunder novels of the present time, and being written by a man in Mr. Roosevelt's position, and published in a magazine of the character of the *Century*, is likely to do infinitely greater harm.

A series of experiments have been made, at the Rochefort arsenal, France, with a view to provide for the concealment of torpedo boats in action. The apparatus used prevents the escape of sparks and fire, and it is said that it reduces the temperature of the smoke to 100°, at which temperature, instead of rising, it spreads over the surface of the water, concealing the boat.

By a method, practiced in England, for making copper steam pipes, the copper is electrically deposited in the proper form, doing away entirely with brazing. This has been done before, but the strength of the copper has been destroyed. This difficulty is said to have been obviated, and copper pipes of great strength obtained.

Questions and Answers.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(92) J. R. Z., Jersey City, N J., writes: Some of our men claim that an ice boat travels faster than the wind. I cannot believe this. Is it true? *A.*—It is undoubtedly true that an ice boat may travel faster than the wind, when moving at an angle to the direction in which the wind blows.

(93) W. L., Reading, Pa., asks: 1. Is there any kind of flux which I can put in a cupola that will make hard iron soft? *A.*—No. If you want soft castings you must use such grades of iron as will produce soft castings. 2. In what book will I find how to mix iron? *A.*—American Foundry Practice, by Thomas D. West.

(94) Inquirer, Atlanta, Ga., asks: 1. What is meant by the lap of a slide valve? *A.*—See AMERICAN MACHINIST, Oct. 10, p. 2, 1885. 2. What should be the proportions of steam ports to the diameter of cylinder? *A.*—See AMERICAN MACHINIST, Sept. 5, 1885, p, 5. 3. Do the Corliss engines have any lead? *A.*—Yes.

(95) J. K. C., Kokomo, Ind., writes: Please state, to settle a dispute, what is meant by an engine running over or under? *A.*—Place yourself at the cylinder of a horizontal engine, looking towards the fly-wheel. If the top of the fly-wheel moves from you the engine runs over; if it moves towards you it runs under.

(96) J. S., New York, writes: Please give me the general dimensions of a 2 horse-power vertical steam engine. The diameter of bore, length of stroke, size of steam and exhaust ports. *A.*—Diameter of cylinder, 3 inches; stroke, 5 inches; number of revolutions, 300; mean effective steam pressure, 50 pounds; steam ports, ¼ inch x 1¼ inch; exhaust port, ⅛ inch x 1¼ inch, or less in width if the design of valve will allow it. See AMERICAN MACHINIST, Sept. 5, p. 5, 1885.

(97) J. A. B., Hamilton, Ont., writes: I would like your opinion as to the comparative advantages of gears or belting for transmitting motion from engine to roll train 7, 8, 9, 10, or 12 in. train. Which is easiest on engine and train, and why? Which takes the most power? *A.*—The belt would probably be somewhat easier on the engine, and would consume a little less power than gearing, though we do not think there would be much difference in that respect.

(98) C. A. D., Laceyville, Pa., writes: At the end of a 2½ inch line shaft, 10 feet long and running 300 revolutions per minute, a saw-mill is attached, requiring say 40 horse-power. How much more power would it require to drive the mill if the shaft is extended 50 feet, the power being applied at one end and taken off at the other, as at present? *A.*—There will be no difference except that due to the friction of the fifty feet of shafting, which should be only a fraction of one horse-power.

(99) P. & M., write: Is there anything besides sand that brass can be moulded in? How can we get brass of a bright color when taken from the sand? Is it at all possible to get a cylinder clean without having a lot of sand holes on top when it is faced up. *A.*—L. C. Jewett replies to these queries as follows: "Brass can be cast in iron moulds if the casting is of such shape as not to bind in shrinking. Brass can be made bright by dipping in acid, as for example equal parts of sulphuric acid, nitric acid and water. A little muriatic acid helps it. To clean brass for dipping, remove all sand and keep free from grease or oil. It is better to rumble the brass in a wooden barrel immersed in water, after the sand is removed; then dip in the acid, immersing for 30 seconds, then work in clean water and dry in sawdust. A sound cylinder, brass or iron, is obtained by having a well vented mould and core, clean metal, well kimmed and poured warm."

(100) P. P., Birmingham, Ala., asks: 1. How and where could I best learn mechanical drawing? I am a successful iron moulder, 26 years of age, but convinced that, without the knowledge of drawing, the only chance is to pound sand a lifetime. Would you advise me, at this age, to go to some school of that kind? *A.*—That depends upon circumstances. If you are so situated as to make it practicable to give up working at your trade, and take a regular course in a technical school, it would of course, be a good thing for you to do. But if you wish to learn drawing only, you can in most of the large cities find night schools where it is taught. Some are free, and others are taught by draftsmen who charge for their services. Or you can procure the back numbers and take up the study of the articles on this subject now running in the AMERICAN MACHINIST, from which, if you have a fair capacity for such knowledge, you will be able to obtain a good acquaintance with the subject. 2.

What would be the time required to obtain a good knowledge, and what would be the expense? *A.*—The length of time required would be from one year to four years, depending upon your present acquaintance with kindred subjects, your capacity for absorbing such knowledge, and the amount of time per day which you are able or disposed to devote to it.

(101) W. D. Z., Philadelphia, Pa., writes: We have two boilers, either of which will do the work required without forcing. Will we burn less coal by using one or both boilers? *A.*—As you state the case, our opinion is that you will burn the least coal by using only one of the boilers.

(102) G. D., Midland, Mich., asks: What is the right angle for a globe valve face? *A.*—The angle formed by the face and a line drawn parallel to the center line of valve, we have always made equal to 45 degrees. Sometimes the purposes for which the valve is to be used will require a different angle.

(103) C. N. H., Brooklyn, N. Y., writes: Will you inform a constant reader of your paper of some means of protecting the eyes from chips from the lathe? I have suffered much lately from them. *A.*—You can get glasses from any optician that will protect the eyes, but you will not be satisfied with them. Machinists must get accustomed to these things, and learn to "dodge" chips to the best of their ability.

(104) L. D. P., Rochester, N. Y., asks: Will you please inform me as to the definition of the electrical terms, volt, ohm and ampere. *A.*—Volt—the standard unit of electrical tension, or electro-motive force. Ohm—the standard measure of electrical resistance which is nearly equal to the resistance of a wire of pure copper .05 inches in diameter, and 250 feet long. Ampere—the standard unit of volume of electro-magnetic currents.

(105) W. H. B., Marion, O., asks: Can a left-hand thread be cut on a bolt with a right-hand die, and a left-hand thread tapped with a right-hand tap? If so, please explain how it is done. *A.*—Left-hand threads are sometimes cut by right-hand dies, but only as an accidental circumstance, which is of no practical value. We have never investigated the causes of the phenomenon. We do not think left-hand threads can be cut with an ordinary right hand tap.

(106) W. E. D., Middletown, Conn., asks: 1 How much steam will it require to run an engine 2 ' x 3½", 6 inch balance wheel, supposing the engine is built properly, with a D valve? *A.*—Your question is a model of incompleteness. You do not say whether you propose to run your engine at one or five hundred revolutions per minute, or with ten or one hundred pounds steam pressure. Assuming you run with 100 pounds steam pressure, and 300 revolutions per minute the consumption of steam will be about 100 pounds per hour.

(107) A. B. C., ——asks: 1. What should be the least dimensions of steam and exhaust ports for an engine having a cylinder 8 x 8 inches, piston speed 400 feet, valve to have no lap; exhaust nozzle to be 1⅛ square inches in area; average steam chest pressure 100 pounds per square inch? *A.*—Steam ports ¾ x 6¾ inches; exhaust port 1½ x 6¾ inches. 2. What would be the available horse-power of the same? *A.*—About 45 horse-power. 3. Would the common D valve be as satisfactory as any. *A.*—The D valve is the simplest, and if properly proportioned will give good results.

(108) H. W., Fitchburg, Mass., writes: I have an engine 4½" × 12"; steam ports 2⅛" × ⅜"-exhaust port 2⅛" × ½"; bridges ⅜"; outside lap ⅛"; inside lap ⅛". An automatic valve that will cut off from 0 to ¾ stroke works on back of main valve. How high piston speed can I run this engine at to advantage, and what power can I get with 100 pounds of steam, economy of fuel not important? *A.*—Your valve and ports are not well proportioned. You have, for one thing, no more exhaust lead than you have steam lead, which will choke the exhaust. You might probably run at 400 feet piston speed, getting about 8 horse-power

(109) H. S., Campbell Hill, Ill., asks: Has anyone ever made tests of cast-iron, using bars which were cast large and ground to the size required for testing? It seems to me that it might be of interest to note the difference, if any. I am under the impression that there would be. *A.*—There have been tests made with cast-iron bars in the rough, for the purpose of ascertaining the strength of certain brands of cast-iron. The results of tests of the strength of cast-iron tabulated in scientific works have been obtained from cast-iron bars planed to size. We do not know of any reliable tests of the relative strength of finished cast-iron bars, and bars in the rough.

(110) J. F. G., Chattanooga, Tenn., writes: I have charge of a boiler of the following dimensions; length, 18 feet; diameter, 3 feet 3 inches; 5 flues 8 inches diameter; brick stack 2 feet square inside and 35 feet high; steam pressure 60 pounds. 1. Is that boiler large enough to supply steam for a 50 horse-power engine? *A.*—With a fairly good engine your boiler is about half large enough. Your chimney would do very well if carried up to a height of 60 feet. 2. Would it be of any benefit to put a steam drum or dome on the boiler; *A.*—The boiler should have either a dome or a perforated pipe from which to take steam. 3. Can you tell me of some reliable compound that will clean boilers without injuring them? *A.*—There are compounds guaranteed safe and reliable, but not having tried them, we cannot recommend them.

(111) A. T. D., New Orleans, writes: I have recently put up three lines of shafting with hangers 8 feet 6 inches apart. Each line is about 26 feet long, 1 11-16 diameter, runs at 125 revolutions, and drives three engine lathes and three hand lathes on ordinary manual training work. Are the hangers too far apart? *A.*—This depends much upon circumstances. If the power is taken off close to the hangers, or if the belts running to the lathes are so arranged that one will counteract the pull produced by another, then the distance named may do very well, but under ordinary conditions we should prefer to have them closer by about one foot. 2. Our planer is a 22 inch x 22 inch x 4 feet. Would 20 feet a minute be too fast to run it? *A.*—No; that is about the proper speed for general work.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

Planed bevel gears. Grant, see page 16.

Link-Belting.

Send for catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Machinery Co., Chicago and N. Y.

New features on engine lathes, Lodge, Davis & Co

New features on drill presses, Lodge. Davis & Co.

New features on shapers, Lodge Davis & Co.

New features on brass tools, Lodge, Davis & Co.

Special bargains in tools taken in exchange for ours Lodge, Davis & Co.

See special ads. pages 15 and 16, Lodge, Davis & Co.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

Lamb Knitting Machine Co., Chicopee Falls, Mass.

Machine work and pattern making. Anderson Machine Works, Peekskill, N. Y.

Light articles built to order by the American Sewing Machine Co., Philadelphia, Pa.

The Improved Justice Hammer. Williams, White & Co., Moline, Ill., manufacturers.

The Best Upright Hammers run by belt are made by W. P. Duncan & Co., Bellefonte, Pa.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

Solid Nickel-Seated "Pop" Safety Valves. Consolidated Safety Valve Co., 111 Liberty st., N. Y.

R. Dudgeon, 24 Columbia st., New York. Improved Hydraulic Jacks and Roller Tube Expanders.

Light and fine machinery to order; foot lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

Davis Key-Seating Machines, kept in stock, by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

For first-class automatic engines write to Williams Engine Co., 447 North street, Baltimore, Md.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

"How to Keep Boilers Clean." A book mailed free, by James E. Hotchkiss, 120 Liberty st., N. Y.

Ice and Refrigerating Machines, 124 built, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

Selden Packing, for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Drawing Materials, all kinds. Get catalogue. Mention this paper. G. S. Woolman, 116 Fulton st., N.Y.

Burnham's New Improved Turbine; sold at cost of manufacturing and advertising. Address York, Pa.

The Improved Tabor Steam Engine Indicator, made and sold by The Ashcroft Mfg. Co., 111 Liberty st., N. Y.

For the latest improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Gears, racks or ratchets, all sizes, cut or furnished. E. E. Garvin & Co., manufacturers, 139-143 Center street, New York City.

Engine lathes, hand lathes, fine tools, files and supplies for machinists and other metal workers. Frasse & Co., 92 Park Row, N. Y.

Berryman Patent Feed Water Heater and Purifier, and the Economic Boiler Feed Pump. Benj. F. Kelley, 91 Liberty st., New York.

Nicholson & Waterman, Providence, R. I., two 48 in. horizontal boring mills; 5 in. cutting-off machines; 14, 16, and 30 in. engine lathes.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa

Mechanical drawing, calculations, etc., taught by mail; just what the young mechanic needs most to know. I. D. Boyer, 324 E. 3d street, Dayton, O.

Curtis Pressure Regulators, Curtis Return Trap, Curtis Damper Regulator. See Feb. 11, p 10. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

Quints' Pat. Auto. Steam Engine Governor. Correspondence solicited from mfrs. of Throttle Gov'n Engines. Leonard & McCoy, 118 Liberty st., N. Y.

Iron, brass and copper spooled wire is a necessity to the consumer and a great convenience to the trade. S. A. Smith, agent, 23 Canal st., Chicago, Ill.

Machinists' supplies, brass goods, m'f'rs' supplies, polishing materials, all kinds wire, metals, etc., in any quantity. Jordan & Gottfried, 208 Canal st., N.Y.

For Best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st., N.Y. Send for des'n.

The Holly Manufacturing Company, of Lockport, N. Y., will send, on application, their pamphlet, illustrating pumping machinery and reports of duty trials.

Only a few more left, therefore you should send 14 cents at once and get a copy of our 300 page illustrated catalogue. Montgomery & Co., 105 Fulton street, New York.

For practical working drawings of macinery, call on A. K. Mansfield & Co., 280 Broadway, N. Y. Lifelong mechanics; one formerly R. R. superintendent motive power. Important references.

W. H. Hoffman, consulting engineer, 94 Liberty st., N. Y. Mechanical engineering in all its branches; working drawings for the transmission of power by steam, water, air and electricity.

New book on gears; Tables giving 3,094 diameters, with rules for calculation of movements of shafts, etc.; sent on receipt of P. O. Note; price, 50 cts. Address C. B. Long, M. E., Worcester, Mass.

Parties requiring milling machine or screw machine work furnished, in large or small quantities, will please write to the manufacturers, E. E. Garvin & Co., 139, 141, 143 Centre st., New York City.

Hot Water Supply. A practical treatise on the fitting of hot-water apparatus for domestic and general purposes. By F. Dye. 82 pages, with 25 illustrations. 12mo., cloth, $1. Send for catalogue. E. & F. N. Spon, 35 Murray st., N. Y

Wanted—Numbers 1, 2 and 4 of volume IV., 1881; must be in excellent condition for binding; if soiled we cannot use them; for copies described as above we will pay 25c. each, and prefer to have the whole three if possible. Parties favoring us will kindly write name and address on wrapper. AM. MACHINIST Publishing Co., 96 Fulton street, N. Y.

Selling out—We are offering our entire stock of lathes, planers, drills, shaping machines, shafting, etc., at prices below factory cost, preparatory to closing our business in February. Send for list before purchasing your tools elsewhere, and save money. Fraser & Archer, 121 Chambers street, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines, and current practice in testing engines and boilers. Price, $2, postpaid. Published by John Wiley & Sons, 15 Astor Place, New York

"Binders" for the AMERICAN MACHINIST. Two styles—the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, the full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G Co., 96 Fulton st., New York.

The series of articles by J. G. A. Meyer, on "Practical Drawing," now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October, 23, 1886 issue, and up to and including January 14, 1888 issue, 41 articles have been so far published. Copies containing these articles, sent by mail to any part of this country or Canada, at 5 cents each. AMERICAN MACHINIST PUBLISHING Co., 96 Fulton street, New York.

"Modern Locomotive Construction," by J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 56 articles have thus far appeared up to and including the January 21, 1888 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING Co., 96 Fulton street, New York.

MANUFACTURES.

S. A. Fuller will open a steam laundry at Atlanta, Ga.

W. C. Quinlan will start a broom factory at Dalton, Ga.

Broom handles are shipped from the United States to Australia.

C. C Mengel & Co. will build a saw-mill at Louisville, Ky.

H. Gunther & Bro. will build an iron foundry at Owensboro, Ky.

A furniture factory will be built at Macon, Ga., by L. McManus.

W. D. Young contemplates building a planing mill at Tallulah, Ga.

The Union Lumber Company will build a mill at Arkansas City, Ark.

The Meridian (Miss.) Car Works Company have applied for a charter.

The Fork Shoals cotton mills, Fork Shoals, S. C., will add new machinery.

The Bonifay (Fla.) Manufacturing Company are building a large lumber mill.

J. T. Harper will build and equip a steam grist mill at Cerulean Springs, Ky.

The Chestertown (Md.) Water Company think of putting up an electric light plant.

The flour mill of G. T. Steiner & Co., recently burned at Jefferson, Md., will be rebuilt at once.

Pittsburgh manufacturers claim that the production of wrought-iron tubes is quite overdone.

The Empire Lumber Company, of St. Joseph, Mo., contemplate building a large mill at Fort Smith, Ark.

The South Florida Foundry and Machine Company are building an addition to their works at Orlando, Fla.

A stock company is being organized at Athol, Mass., to put in arc and incandescent plants. Water power will be used.

The Ayar Machine Works, Salem, N. J., send us an illustrated catalogue of presses, dies, canners' tools, steam engines, boilers and fittings.

E. P. Rosback, successor to Rosback & Rad, Chicago, Ill., has issued a circular of perforating machines and small machines in use by printers.

The Chester Steel Castings Company, of Philadelphia, have booked about 30 per cent. more business so far this year than during the corresponding period last year.

There has been a consolidation at Bethlehem, Pa., of Lloyd Valve Works and the Bethlehem Foundry and Machine Works, which has resulted in work being resumed.

A new company has been organized at Portsmouth, N. H., known as Portsmouth Machine Company. This company bought out the old company doing business under the same title.

Notices are being posted in several of the New England cotton mills of a liberal advance in wages. In the steel mills of the country there is a general move looking to a reduction of wages.

The Western Electric Light Company, Boston, Mass., has applied electric propulsion to an ordinary car on the West End street railroad, and propose to give the Julien storage battery a thorough trial.

The United States Scale Company, Terre Haute, Ind., contemplate building large additions to their works. In addition to making scales, the company proposes to do a general foundry and machine business.

The Hoppes Manufacturing Company, Springfield, Ohio, are occupying their new building, and are at present engaged in putting up extensive additions to their works, made necessary by the large increase in their business.

C. Vanhagen, Collegeville, Pa., has perfected a machine for forging twist drills, upon which he has been at work for several years. The machine is said to be quite simple, and to forge the spiral perfect in form and finish.

The Baltimore and Ohio railroad has begun, at the Mount Clare shops, the construction of 25 large locomotives, and will contract for as many more. The company has also contracted for 250 refrigerator cars, the Michigan Car Company getting the contract.

F. R. Whitney, of Lewiston, Maine, has invented an electrical apparatus for regulating heat. When the temperature reaches the desired degree, clock work is started which closes the dampers. The same clock work opens the dampers when the temperature falls below that desired.

The plant and patents of the Whitney Arms Company, of New Haven, founded by Eli Whitney, inventor of the cotton gin, have been absorbed by the Winchester Repeating Arms Company. It is generally understood to be a movement in the direction of a combination of firearms manufacturers.

The American Standard Gauge and Tool Works, (James A. Taylor & Co.) have purchased the plant and business for gauge making from the Betts Machine Company, and will continue the business at Wilmington, Del. Mr. Taylor was one of the original firm of gauge makers who started the business in Philadelphia in 1878, this firm afterwards selling out later to the Betts Machine Company.

The Electric Light Company at Palmer, Mass. are laying out the ground for a building 50 by 80 feet on the lot recently bought of Mr. Converse, near the New London Northern Railroad's old depot, for a plant which will supply Palmer and Monson, and they hope to get some lights into Thorndike, Bondville and Three Rivers. Work will be pushed as rapidly as the weather will permit.

Aside from the flourishing steam pump business carried on by Dean Bros., of Indianapolis, Ind., they have a patent hand truck for warehouse and shop use, which looks as if it could be advantageously put on the market. Instead of wood, the handles and the cross-bars are made of wrought pipe of suitable size, slightly flattened on the sides to give it increased strength. The nose of the truck is of steel, securely welded in.

A press telegram from Chicago says: There are many rumors current about coming developments in regard to the Pullman Palace Car Company. When sifted down, these point to an intention on the part of the managers to enter the field as providers of motive power and it is understood that in a few weeks the construction of an immense plant for the manufacture of locomotives will be begun. No details are given beyond the confirmation from the officers of the company, of the statement that they will certainly add the construction of locomotives to their present business.

Few persons not mechanics, and not all mechanics, appreciate the almost countless diversity of uses to which link belting is now put, mostly in "conveying" things. It has a wide range of uses between the conveying of Southern cotton and that of Northern grain, shoddy, coal, saw logs, bar iron, etc. One of its latest adaptations, devised by the Link Belt Machinery Company, of Chicago, is driving a combined apparatus for the purpose of crushing coal to the size required for use in locomotive tenders, and coaling the tender at the regular coaling station, by means of a series of scrapers running in an iron trough.

The Buckeye Engine Company, Salem, Ohio, has issued a catalogue in two parts, illustrating and describing engines, boilers, etc., made by them. As usual with this company, the illustrations are very fine, the text complete and the printing excellent. Part 1 of the catalogue illustrates the Buckeye engine in various forms, and contains considerable argument and data in regard to choice of engines, performance, etc. Part 2 is devoted to the use of the indicator, boiler construction and setting, horse-power of boilers, management of boilers, chimney construction, and numerous subjects connected with steam engineering; also useful tables, etc.

David Boyle, builder of the Boyle ice machine and refrigerating apparatus, Chicago, Ill., writes us: Please notice that I am busy filling the following contracts, viz.: 30 ton ice-making machine for the Knoxville (Tenn.) Ice Company; 45 ton ice-making machine for the Atlanta City Brewing Company, Ga.; 15 ton ice-making machine for the Greenville (Miss.) Ice and Coal Company; 5 ton ice-making machine for the Kissimee (Fla.) Ice Factory Company. All of these machines are additions to machines of my make, operated by the same purchasers for several years past. I have just received a letter from New South Wales, asking prices of machines. The writer says he saw my advertisement in the AMERICAN MACINIST.

Machinists' Supplies and Iron.

New York, Feb. 16, 1888.

Iron—American Pig—There seems to be no uneasiness on the part of either buyers or sellers regarding the future, and trade therefore drifts along in a quiet way. We quote Standard Lehigh brands $21 to $21.50 for No. 1 X Foundry, with outside brands obtainable at $20 to $20.50. No. 2 Foundry is quoted $19 to $19.50 for Standard Lehigh brands, but other brands are obtainable at $18 to $18.50, and Grey Forge ranges from $16 up to $17.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate, 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.

Wanted—Men to sell planes, see page 1.

Draftsman wanted; young man with some experience. Address B. F. Co., care Am. Machinist.

Wanted—Draftsman as assistant; Apply stating exp. and salary expected to P. O. Box 302, Tiffin, O.

Situation wanted by a first-class mechanical drafts man and machine designer. O. M., Am. Machinist.

Machine shop foreman at present engaged on general machinery and repairs desires to change. F. S., Am. Machinist.

Good mechanical draftsman wants situation, boiler and engine work preferred. Address Arnold, 1807 N. 16th st., Philadelphia, Pa.

Designer and draftsman desires correspondence with parties who wish to introduce new lines of machinery and specialties. P. R., Am. Machnist.

Wanted—Position as foreman pattern maker; has charge of fifteen to twenty men; large shop preferred; wants to change. Box 83, Am. Machinist.

Wanted—At once, 2 or 3 competent draftsmen accustomed to locomotive work. State age, previous experience, and references. Brooks Locomotive Works, Dunkirk, N. Y.

Wanted—Situation by foreman brass moulder who thoroughly understands trade and mixing of all kinds of brass and refining of scrap brass. Address Brass Moulder, Am. Machinist.

Wanted—By young man, practical machinist, with knowledge of drafting, position (salesman preferred) with machinery house; best of references. H. C. H., 401 Macon st., Brooklyn, N. Y.

Situation wanted as foreman boilermaker by a thorough mechanic who has been foreman a number of years, and can give reference as to ability, etc. Address J. W. T., Am. Machinist.

Practical mechanic and manager wants charge of foundry and machine shop working 25 to 100 men, doing general work, millwrighting or manufacturing. Address Manufacturer, Am. Machinist.

Two machinists want to change location on or before May 1; small town no objection; Middle or Western States preferred; correspondence solicited. Address Frank Jefferson, 546 E. 6th st., Erie, Pa.

Wanted—At once, first-class machinists accustomed to high-speed engines; one lathe, one planer and two vise hands; good pay and steady work. Davenport Foundry and Machine Co., Davenport, Iowa.

Wanted—Positon by young man, in some manufacturing line, or supply house; theoretical and practical in machinery; capable of doing general office work, traveling, etc. J. L. L., Am. Machinist.

A foreman pattern maker to take charge of six to eight men in a locomotive works; must be experienced in locomotive work; state previous experience and wages required. P., Am. Machinist.

Wanted—Live men with some engineering knowledge, to introduce the Edson recording steam gauge to manufacturers, and all steam users in their locality. For particulars address J. B. Edson, 91 Liberty st., N. Y.

Wanted—Head draftsman in machine shop, foundry and boiler works in Pennsylvania; graduate of technical school with experience preferred. Address, giving particulars, and stating salary expected, N. O. P., Am. Machinist.

Wanted—By a practical machinist and iron founder who has risen from apprentice at 16 years to journeyman foreman and superintendent; practical, economical, and with good record, 37 years' old, a change after April 1, 1888. L. F. Maron, Am. Machinist.

Practical man with large experience designing and constructing machines and tools for brass and iron work, good inspector, with method of keeping cost account, experience in buying and selling, desires to engage with other parties; references from present firm. Address B. W. Am. Machinist.

MISCELLANEOUS WANTS.

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Gerlach's Engineers' specialties beat the world, Send for price list. Crescent Mfg. Co., Cleveland, O.

Crescent grease cup for shafting beats them all. Sample free. Crescent Mfg. Co., Cleveland. Ohio.

Hard rubber blowing and pressing dies and machinery a specialty. E. O. Chase, Newark, N. J.

Wanted—Parties having machinery specialties to build, to correspond with. Box 75, Am. Machinist.

Steam users who desire to keep their boilers clear of scale at a cost of 10 cents a week, should read the card of the Pittsburgh Boiler Scale Resolvent Company on page 12. It will pay them.

A. C. Christensen, 26 Church st., N. Y., mech. and hydraulic engineer. Prepares designs of waterworks pumping stations, drawings of steam pumps, pumping engines, gen. mach'ry and pat. drawings.

CHARLES MURRAY
ENGRAVER ON WOOD
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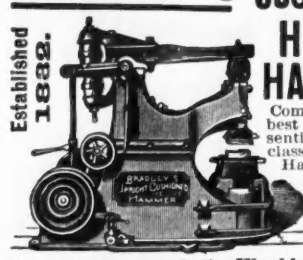
BRADLEY'S UPRIGHT CUSHIONED HELVE HAMMER



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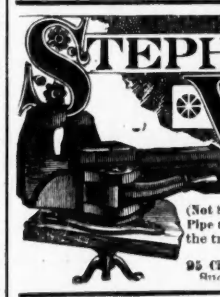

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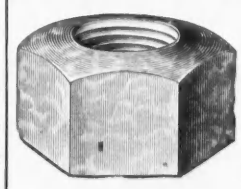

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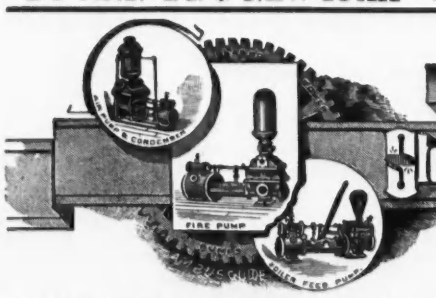

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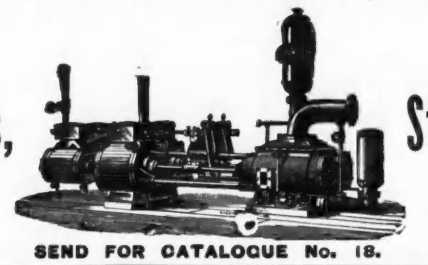

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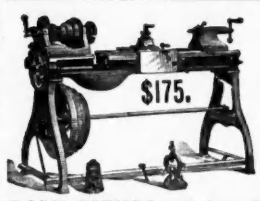

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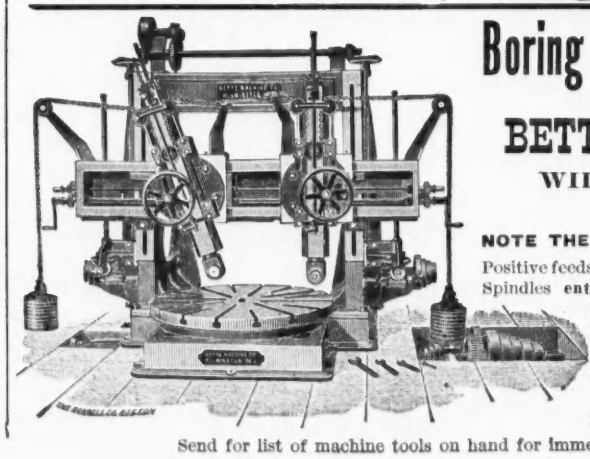

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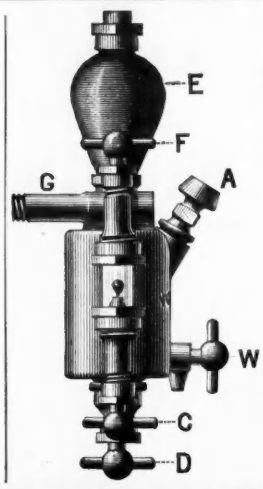

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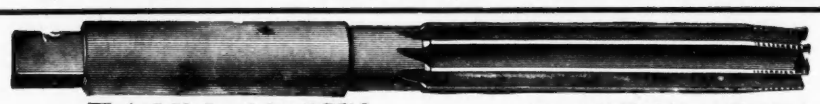

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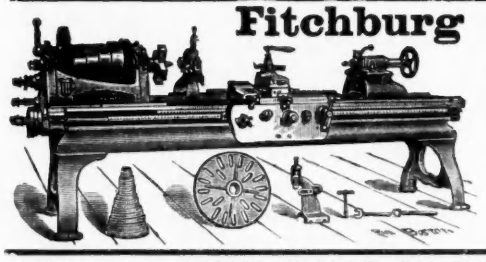

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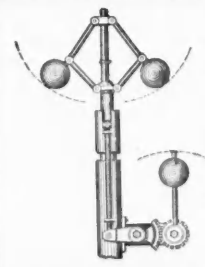

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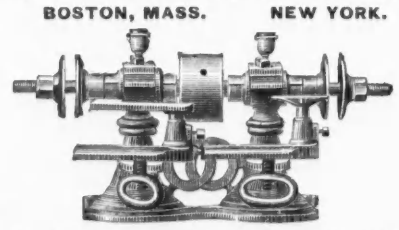

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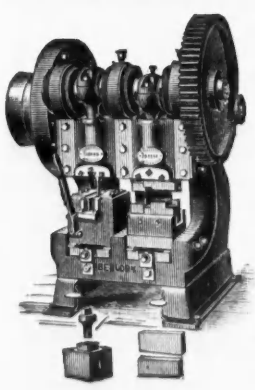

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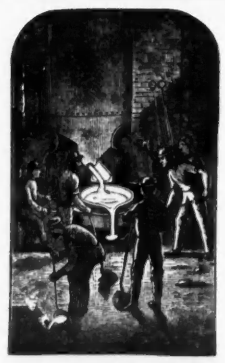

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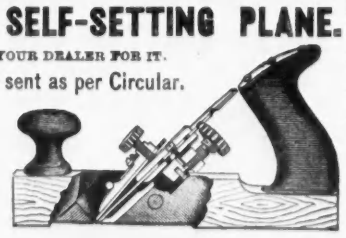

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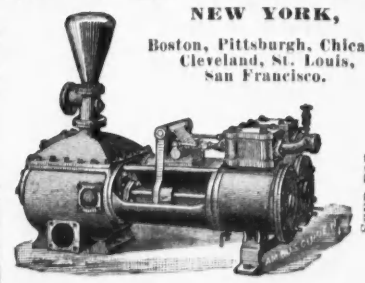

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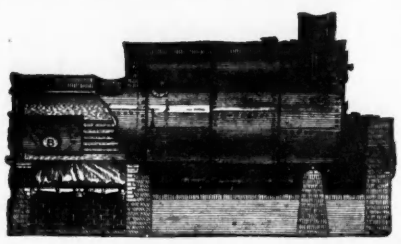

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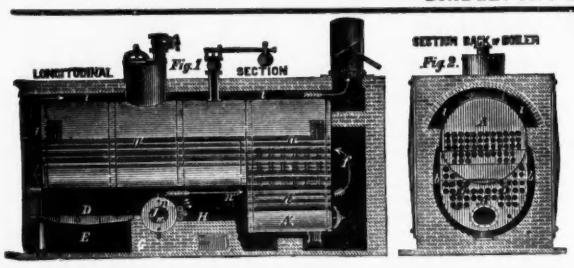

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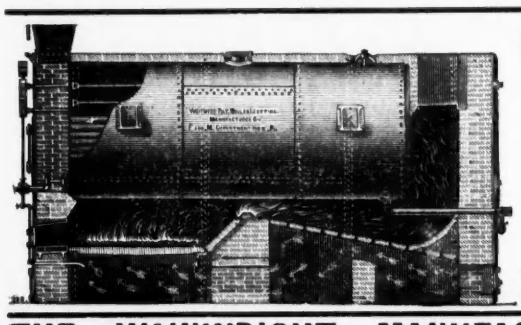

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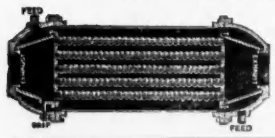

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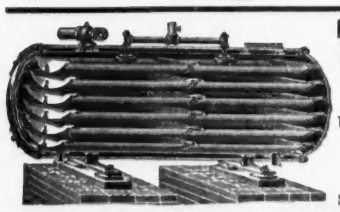

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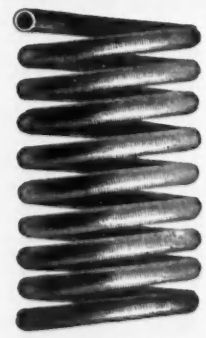

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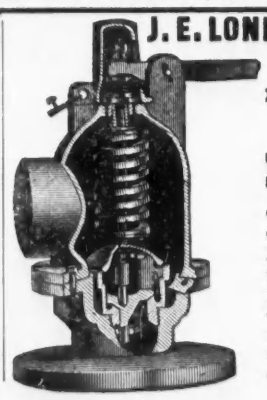

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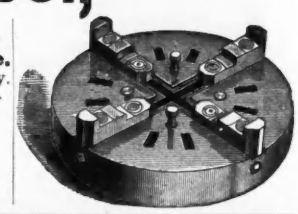

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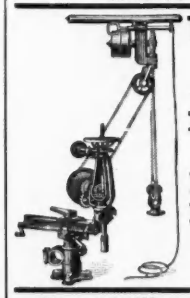

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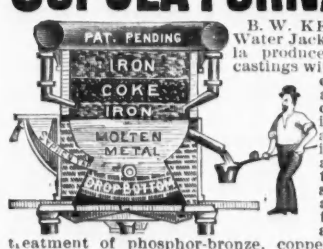

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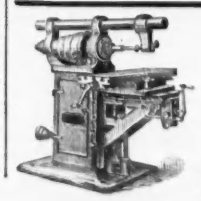

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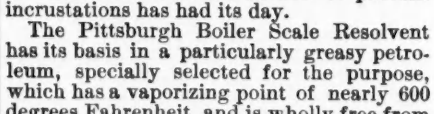

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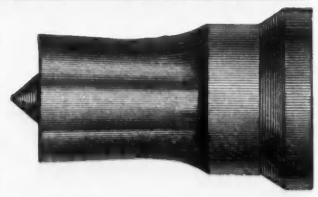

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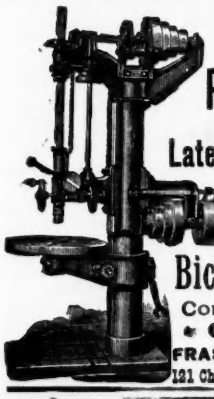

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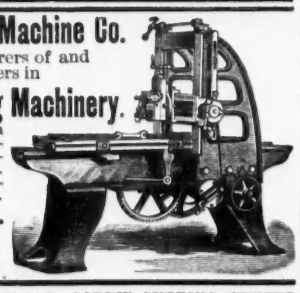

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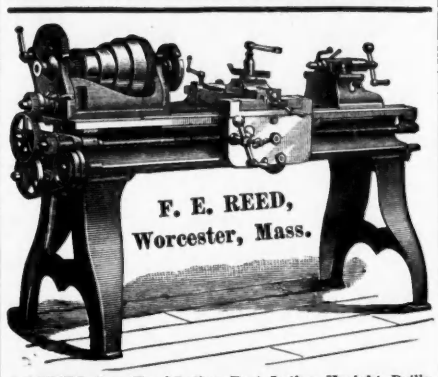

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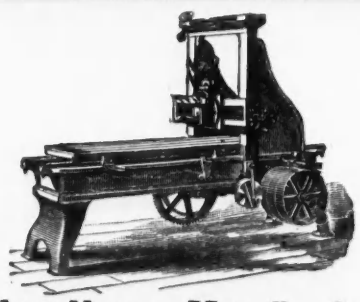

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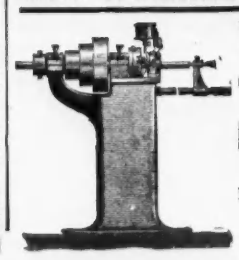

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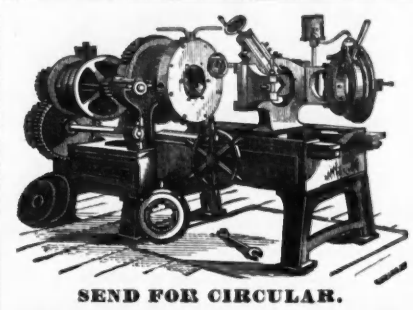

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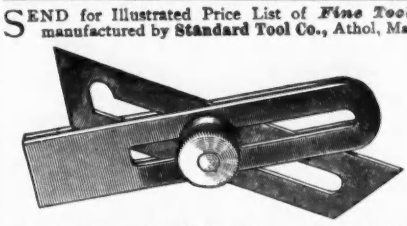

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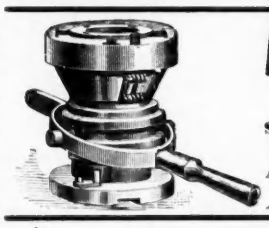

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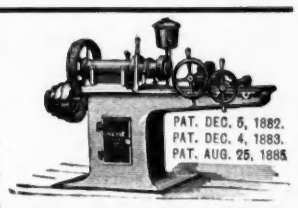

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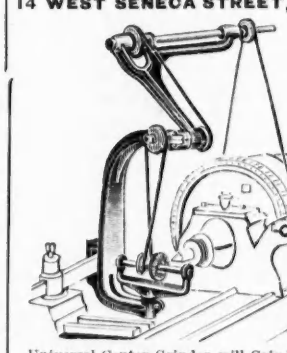

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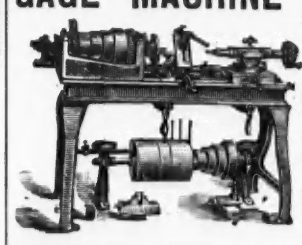

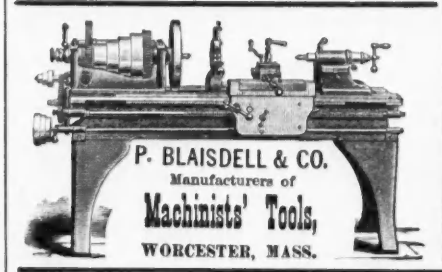

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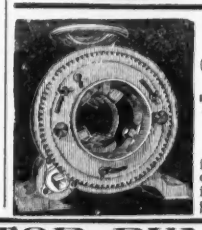

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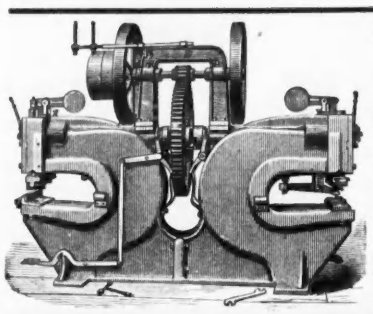

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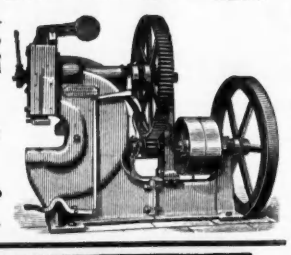

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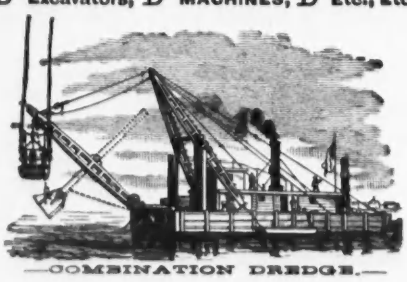

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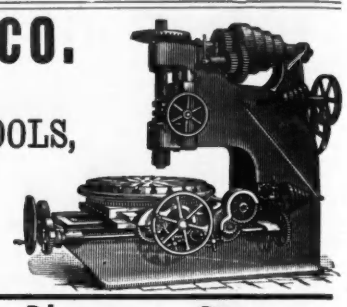

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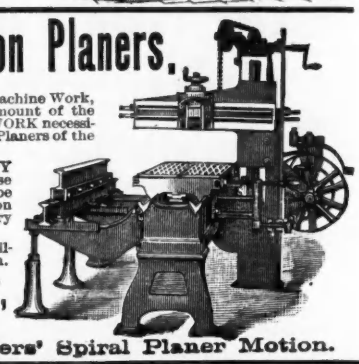

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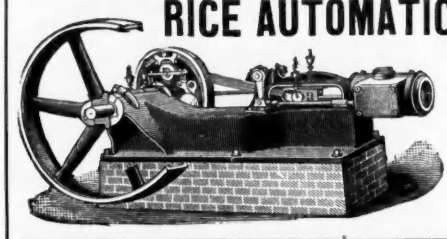

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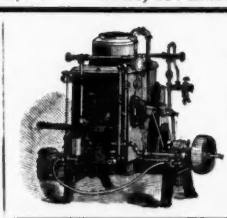

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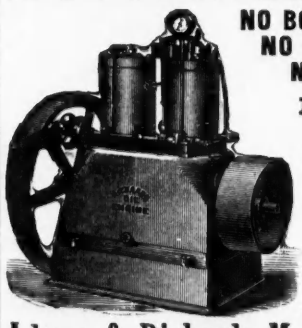

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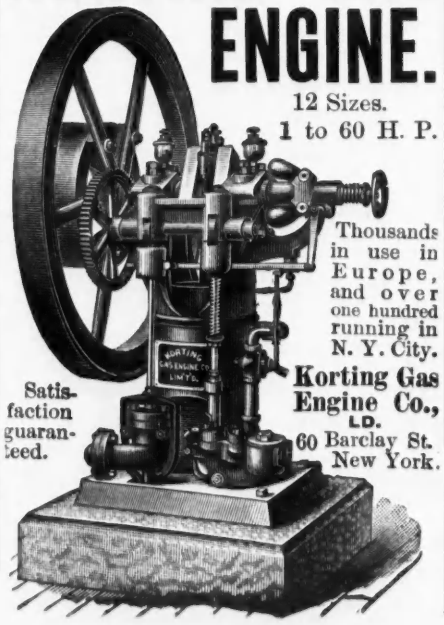

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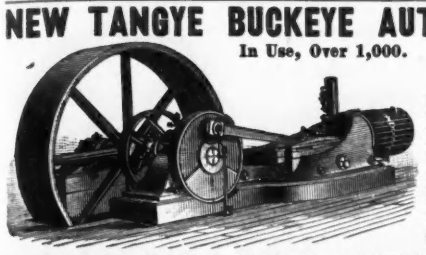

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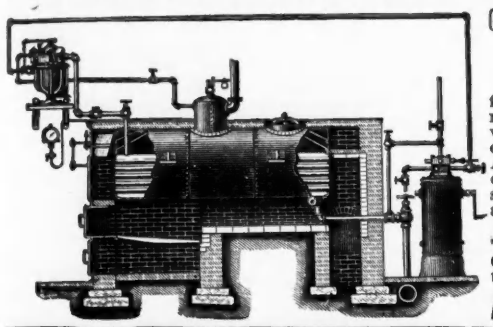

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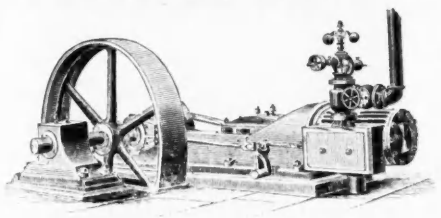

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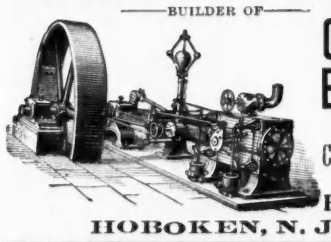

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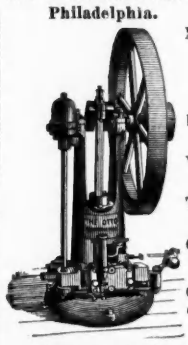

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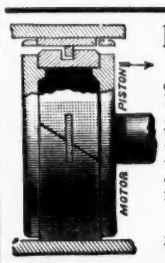

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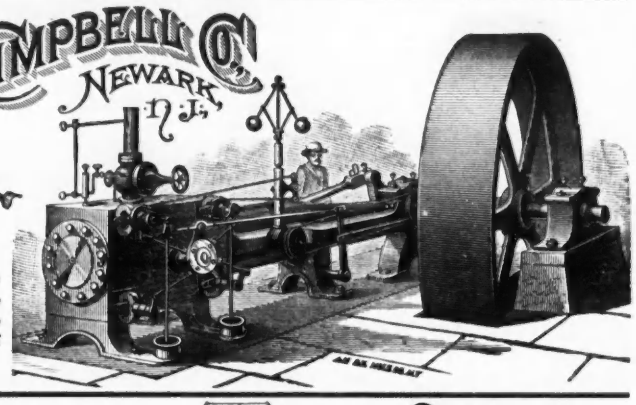

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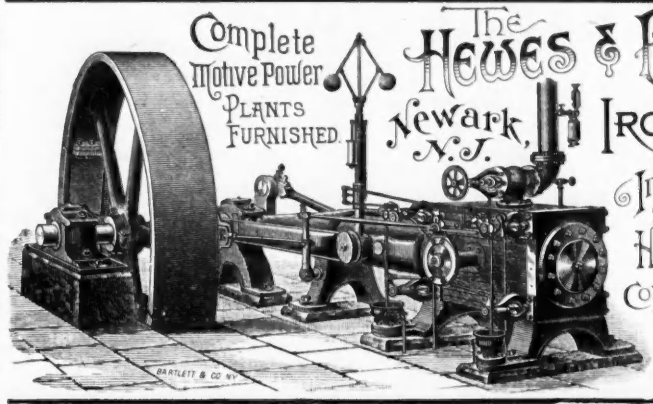

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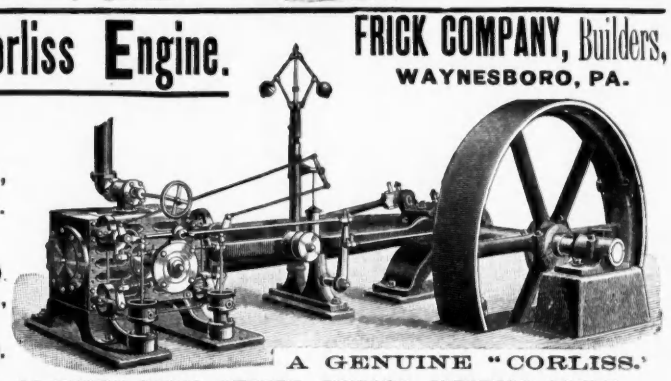

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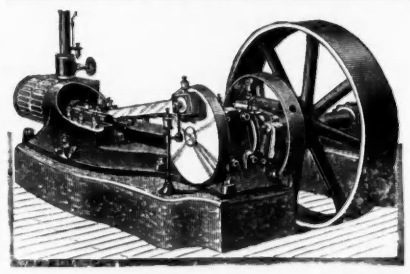

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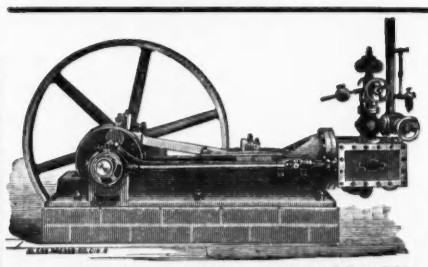

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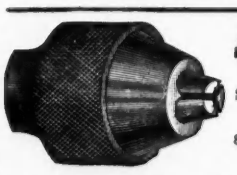

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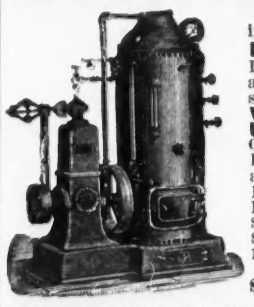

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14	"	6	"	"	"		"
16	"	8	"	"	"		"
24	"	14	"	"	"		"
17	"	8	"	"	"		Lathe & Morse
17	"	10	"	"	"		" "
17	"	8	"	"	"		" "
21	"	10	"	"	"		" "
27	"	16	"	"	"		" "
18	"	8	"	"	"		Flather.
20	"	10	"	"	"		"
18	"	8	"	"	"		Fifield
20	"	8	"	"	"		"
22	"	10	"	"	"		"
24	"	12	"	"	"		"
28	"	16	"	"	"		"
36	"	16	"	"	"		"
16	in. by	16	in. by	4 ft.	Planer.		Hendey
17	"	17	"	4	"		Whitcomb.
22	"	22	"	5	"		"
24	"	24	"	6	"		"
24	"	24	"	8	"		Lathe & Morse
2	"	27	"	7	"		Whitcomb.
30	"	30	"	8	"		"
36	"	36	"	10	"		"
26	"	26	"	8	"		Flather.
26	"	24	"	6	"		Gleason.
30	"	30	"	9	"		"
6 and 8	inch	Str	ke	Shapers.			Boynton & Plummer.
15 and 24	inch		"		"		Hendey.
20	"	25	"		"		Eberhardt.
18	inch	Swing,	Lever	Drill.			Prentice Bros.
20	"	"	Upright	Drill.			" "
25	"	"	"		"		" "
30	"	"	"		"		" "
28	"	"	"		"		Blaisdell
34	"	"	"		"		"

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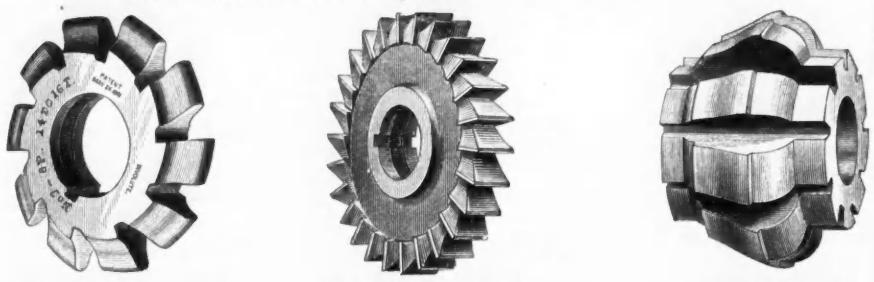
FINE MACHINERY, TOOLS OF PRECISION.



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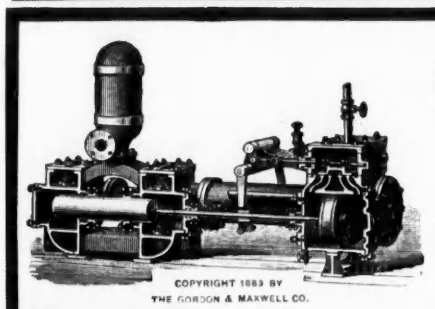
In extending the product of its Milling Department, the BROWN & SHARPE MF'G Co. has made many new varieties of Milling Cutters, and in order to supply the wants of customers, has found it necessary to greatly increase the number carried in stock. The INVOLUTE GEAR CUTTERS in stock are from 3 to 48 pitch, 8 cutters to each pitch. The Epicycloidal are from 2 to 10 pitch, 24 to each pitch. The curves of gear cutters are obtained by machinery. SIDE MILLING CUTTERS, from 3 1-2 in. to 8 in. diameter, are carried in stock. On work having parallel surfaces, these cutters may be used in pairs. FORMED CUTTERS, for cutting various outlines, are made to order. These, as also the Gear Cutters, can be sharpened without changing their original form– a feature appreciated by those producing work in duplicate. By making cutters in large numbers, with expensive special tools, much greater accuracy has been attained than can be reached by the usual methods of manufacture. Users of cutters will generally find it more economical and satisfactory to purchase from experienced makers, rather than to attempt to manufacture for themselves. Catalogues mailed on application. All kinds of cutters made to order.



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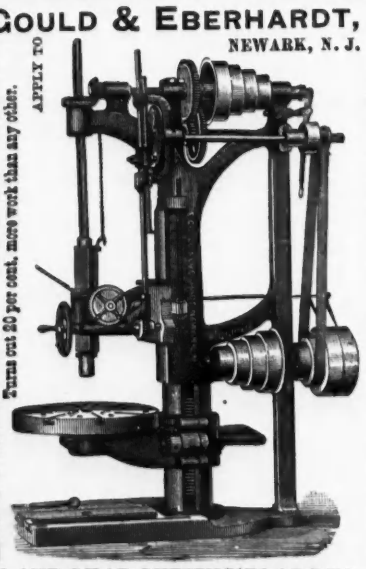

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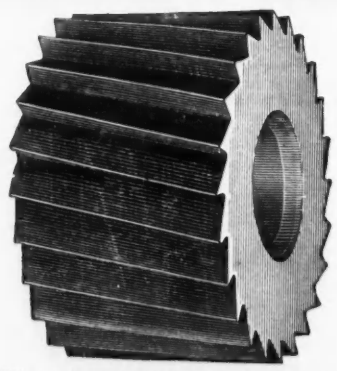

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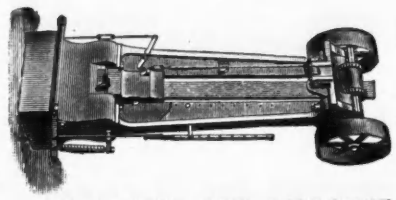

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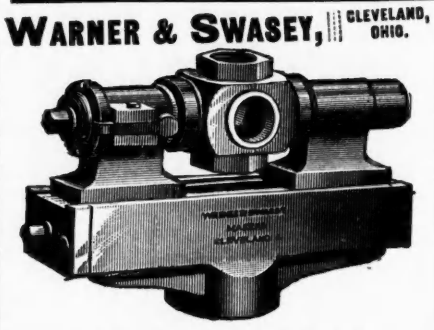

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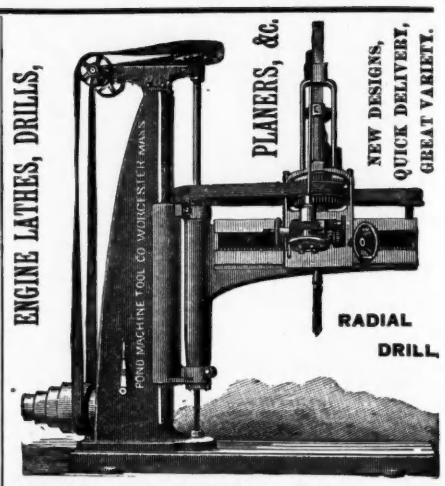

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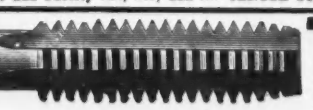

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